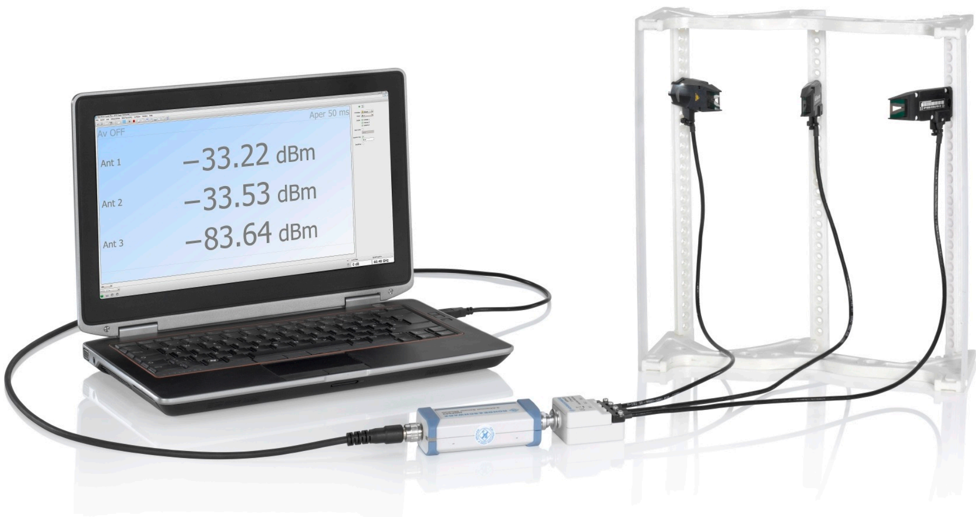
# R&S®NRPM OTA Power Measurement Solution Manual

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Version 11

ROHDE&SCHWARZ
Make ideas real

This document describes the R&S®NRPM OTA power measurement solution, with firmware version 03.40 and higher, including the following components:

- R&S®NRPM3N three-channel sensor module LAN, 1425.8592.02
- R&S®NRPM3 three-channel sensor module, 1425.8563.02
- R&S®NRPM-A90 single-polarized antenna module, 1426.7760.02/.03/.04/.05
- R&S®NRPM-A90D dual-polarized antenna module, 1426.7777.02/.03/.04/.05
- R&S®NRPM-ZD3 feedthrough module, 1425.8786.02
- R&S®NRPM-Z3 three-channel interface module, 1426.7602.02


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1425.8663.02 | Version 11 | R&S®NRPM

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

# Contents

# 1 Safety and regulatory information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the following sections.

### Intended use

The R&S NRPM OTA power measurement solution is intended for accurate power measurements in production, R&D and calibration labs, and for installation and maintenance tasks. Observe the operating conditions and performance limits stated in the specifications document.

The R&S NRPM OTA power measurement solution is designed for use in anechoic environments as RF shielded boxes or benchtop applications in RF test chambers. You can use it for Over-the-Air (OTA) beamforming verification in 5G, WLAN IEEE 802.11ad and IEEE 802.11ay and the calibration of the transmit antenna output power.

Observe the operating conditions and performance limits stated in the specifications document.

### Target audience

The target audience is developers and technicians. The required skills and experience in power measurements depend on the used operating concept.

### Where do I find safety information?

Safety information is part of the product documentation. It warns you of potential dangers and gives instructions on how to prevent personal injury or damage caused by dangerous situations. Safety information is provided as follows:

- In Section 1.1, "Safety instructions", on page 9. The same information is provided in many languages in printed format. The printed "Safety Instructions" for "Power Sensors" (document number 1171.1865.99) are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

## 1.1 Safety instructions

Products from the Rohde & Schwarz group of companies are manufactured according to the highest technical standards. To use the products safely, follow the instructions provided here and in the product documentation. Keep the product documentation nearby and offer it to other users.

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the specifications document, manuals and the printed "Safety Instructions" document. If you are unsure about the appropriate use, contact Rohde & Schwarz customer support.

Using the product requires specialists or specially trained personnel. These users also need sound knowledge of at least one of the languages in which the user interfaces and the product documentation are available.

Reconfigure or adjust the product only as described in the product documentation or the specifications document. Any other modifications can affect safety and are not permitted.

Never open the casing of the product. Only service personnel authorized by Rohde & Schwarz are allowed to repair the product. If any part of the product is damaged or broken, stop using the product. Contact Rohde & Schwarz customer support at https://www.rohde-schwarz.com/support.

#### Operating the product

Only use the product indoors. The product casing is not waterproof.

Observe the ambient conditions stated in the specifications document. Examples of ambient conditions are altitude, operating temperature and climatic loads.

#### Meaning of safety labels

Safety labels on the product warn against potential hazards.

| | |
|---|---|
|  | Potential hazard<br>Read the product documentation to avoid personal injury or product damage. |

| | |
|---|---|
|  | Hot surface<br>Do not touch. Risk of skin burns. Risk of fire. |

## 1.2 Labels on the product

Labels on the product inform about:

- Personal safety
  See "Meaning of safety labels" on page 10.
- Environment safety
  See Table 1-1.
- Identification of the product
  A label on the product shows the device ID, a combination of the device name and the serial number of the product. The serial number identifies the product uniquely. See also Section 6.3.5.1, "Using hostnames", on page 46.
- Sensitive components
  See Table 1-2.

*Table 1-1: Labels regarding environment safety*

| | |
|---|---|
|  | Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its life.<br>For more information, see "Disposing of electrical and electronic equipment" on page 181. |

*Table 1-2: Labels regarding sensitive components*

| | |
|---|---|
|  | Electrostatically sensitive components<br>Indicates sensitivity to touch. Follow the instructions in the product documentation to avoid product damage.<br>See "To prevent antenna damage" on page 17. |

## 1.3 Warning messages in the documentation

A warning message points out a risk or danger that you need to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if you do not follow the safety precautions.

**NOTICE**

Potential risks of damage. Could result in damage to the supported product or to other property.

## 1.4 Where to find key documents on Rohde & Schwarz

Certificates issued to Rohde & Schwarz that are relevant for your country are provided at www.rohde-schwarz.com/key-documents, e.g. concerning:

- Quality management
- Environmental management
- Information security management
- Accreditations

# 2 Welcome to the R&S NRPM OTA power measurement solution

Introduces the R&S NRPM OTA power measurement solution.

## 2.1 Key features

The R&S NRPM OTA power measurement solution is designed to calibrate the transmit antenna output power and test the beamforming function over the air. Applications are in high frequency bands, used in modern high performance wireless system standards, e.g. 5G NR, IEE802.11ad and IEEE802.11ay.

Providing measurements of radiated RF power, the R&S NRPM OTA power measurement solution features:

- Single and dual polarized receiver antenna modules with integrated diode detector
- R&S NRPM3(N) sensor module for readings of receiver antenna modules
- OTA power measurements with up to three antenna modules per R&S NRPM sensor module
- Ethernet and high speed host USB communication interfaces
- Mode for processing frequency lists for short settling times and fast measuring of predefined random frequency points
- High sensitivity
- Fully calibrated system with specified system uncertainty
- Low-reflection antenna module
- Wide range of supported operating systems
- Easy operation with PC measurement applications, or remotely with SCPI commands

For detailed specification, refer to the specifications document.

## 2.2 About the R&S NRPM OTA power measurement solution

The power measurement solution consists of antenna modules, a three-channel sensor module, and interface modules for connecting the antenna modules to the sensor module. A PC measurement application demonstrates the use of the OTA power measurement solution.

The R&S NRPM3 sensor modules provide a high-speed USB interface that constitutes both, the communication port and the power supply connection. The R&S NRPM3N LAN sensor module adds a Gigabit Ethernet interface with Power-over-Ethernet (PoE) power supply.

The single or dual-polarized antenna modules (R&S NRPM-A90, R&S NRPM-A90D) are usually installed within an anechoic chamber, that can be:

- An RF shielded box, e.g. the R&S CMQ200.
  The antenna modules are positioned inside the RF shielded box, the sensor module is outside. The sensor module is connected by the feedthrough module R&S NRPM-ZD3 that provides the interface for up to three antenna modules. Especially designed for use with the R&S CMQ200, you can install up to six of the feedthrough modules. An antenna ring inside the R&S CMQ200 allows you to position and align the antenna modules flexibly according to the application.
- An RF test chamber of larger dimensions.
  The antenna modules and the sensor module are positioned inside the RF test chamber. The interface module R&S NRPM-Z3, directly connected to the sensor module provides the interface for up to three antenna modules.

With the single and dual polarized antenna modules (R&S NRPM-A90, R&S NRPM-A90D), you can calibrate the DUT (transmit antenna) output power and test the beamforming function.

The R&S NRPM measurement is controlled by an arbitrary user-definable measurement application. For a quick startup, Rohde & Schwarz provides the free interactive application R&S Power Viewer, which supports multiple sensor modules in the measurement modes "Continuous Average" and "Trace".

As an alternative way to operate an R&S NRPM3N sensor module, you can use the browser based web user interface.

For communication over the USB with the standardized protocol USBTMC, the drivers and APIs are provided for the operating systems Linux, Mac OS X, MS Windows. It is required that you install a VISA driver on the host operating system, to use the I/O services provided by this standardized software interface library.

The sensor module supports SCPI remote control, e.g. to automate a measurement with a scripting environment.

# 3 Documentation overview

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

www.rohde-schwarz.com/manual/nrpm.

## 3.1 Manual

Introduces the R&S NRPM and describes how to set up and start working with the product. The manual includes general information, and the typical measurement application with programming examples. The sensor module specific functions, and an introduction to remote control and a complete description of the remote control commands are described.

A printed version is delivered with the R&S NRPM OTA Power Measurement Solution.

## 3.2 Tutorials

Tutorials offer guided examples and demonstrations on operating the R&S NRPM. They are provided on the product page of the internet.

## 3.3 Videos

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

## 3.4 Service manual

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

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

## 3.5 Instrument security procedures

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

## 3.6 Printed safety instructions

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

## 3.7 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S NRPM. It also lists the firmware applications and their order numbers, and optional accessories.

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

See www.rohde-schwarz.com/brochure-datasheet/nrpm.

## 3.8 Calibration certificate

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

## 3.9 Release notes and open-source acknowledgment (OSA)

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

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

The open source acknowledgment document is provided on the software CD-ROM, included in the delivery.

See www.rohde-schwarz.com/firmware/nrpm.

### 3.9.1 Application notes, application cards, white papers, etc.

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

www.rohde-schwarz.com/application/nrpm

# 4 Preparing for use

Here, you can find basic information about setting up the product for the first time.



## 4.1 Unpacking and checking

1. Unpack the product carefully.
2. Retain the original packing material. Use it when transporting or shipping the product later.
3. Using the delivery notes, check the equipment for completeness.
4. Check the equipment for damage.

   If the delivery is incomplete or equipment is damaged, contact Rohde & Schwarz.

## 4.2 Choosing the operating site

Specific operating conditions ensure proper operation and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the specifications document.

**Electromagnetic compatibility classes**

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the product is given in the specifications document.

- Class B equipment is suitable for use in:
  – Residential environments
  – Environments that are directly connected to a low-voltage supply network that supplies residential buildings
- Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments.
  If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

## 4.3 Considerations for test setup

Give particular attention to the following aspects when handling the components of the R&S NRPM OTA power measurement solution.

For information on the options for connecting the sensor modules and test setups for the measurements, see Section 6, "Setting up a measurement", on page 32.

**To prevent antenna damage**

Damage is most likely to occur when you connect or disconnect an antenna modules.

1. **NOTICE!** Electrostatic discharge can quickly and imperceptibly damage or destroy the electrostatic sensitive antenna modules.

   Ground yourself to prevent electrostatic discharge damage:

   a) Use a wrist strap and cord to connect yourself to the ground.
   b) Use a conductive floor mat and heel strap combination.

2. **NOTICE!** If you touch the PCB (printed circuit board) of the antenna module, it can bend and thus lead to measurement inaccuracies.

   Always hold the antenna modules by the housing. Take care not to touch the exposed top or bottom of the antenna module PCB.

**EMI impact on measurement results**

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, for example, double-shielded RF and interface cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.
- When using the filtered cable feedthrough module R&S NRPM-ZD3, make sure that the housing of the RF shielded box is grounded, since the feedthrough module is grounded by the housing.

Since the antenna module receives signals in a wideband, also outside the specified frequency bands, always measure in a controlled EM environment. In particular, when working with the R&S NRPM-Z3 interface module.

**Signal input and output levels**

Information on signal levels is provided in the specifications document. Keep the signal levels within the specified ranges to avoid damage to the product and connected devices.

## 4.4 Powering the R&S NRPM3(N) sensor module

The electrical power for a R&S NRPM3(N) sensor module is supplied over one of the following interfaces:

- Host interface
  See "Host interface connector (3)" on page 25.
- LAN PoE interface
  Only available for R&S NRPM3N sensor modules, see"LAN PoE interface (6)" on page 26.

If you use the Ethernet interface of the R&S NRPM3N sensor module, you have to provide the electrical power by power over Ethernet (PoE). In this case, you *cannot* provide the electrical power over the host interface instead.

**Choose the PoE power sourcing equipment (PSE) with care**

Only use PoE power sourcing equipment (PSE) as specified in the IEEE standards 802.3af or IEEE 802.3at. Otherwise, the following can happen:

- If too much power is supplied, the R&S NRPM3N sensor module can get overheated and become damaged as a result.
- If the supplied power is not sufficient, the R&S NRPM3N sensor module does not work properly or not at all.

## 4.5 Hardware requirements

The basic measurement equipment for an OTA power measurement with the R&S NRPM consists of:

- Three channels sensor module R&S NRPM3N or R&S NRPM3.
- Antenna modules:
  - R&S NRPM-A90: one at a minimum, and three at a maximum per sensor module.

- R&S NRPM-A90D: occupies two channels of the sensor module. You can split the antenna module cables of one R&S NRPM-A90D antenna module on two interface or feedthrough modules.
- One of the following:
  - Filtered cable feedthrough module R&S NRPM-ZD3 (RF shielded box) and the interface cable R&S NRPM-ZKD3.
  - Three channel interface module R&S NRPM-Z3 (RF test chamber).
    Tool for fixing the strain relieve: torx screwdriver TX8.
- Desktop PC or laptop with:
  - Required software, see Software requirements and installation. The required operating system depends on the software.
  - USB interface
- LAN connection cables
  RJ-45 Ethernet cable (at least CAT6 STP).
  How to: Section 6.3.4, "Using the LAN connection", on page 42
- USB connection cables
  Double shielded cables, e.g. R&S NRP-ZKU, or NRP-ZK6.

  For this connection, Rohde & Schwarz provides two types of cables:
  - R&S NRP-ZKU cable with a USB connector
  - NRP-ZK6 cable with a push-pull type connector

  You can get both cables with different lengths up to 5 meters.
  How to: Section 6.3.3, "Using the USB connection", on page 39.

See Section 6, "Setting up a measurement", on page 32 for examples on how to set up an R&S NRPM OTA power measurement.

## 4.6 Software requirements and installation

The sensor module is a smart sensor module that you can directly connect to a controlling PC.

To communicate with the sensor module, you can use the VISA I/O standard.

Install the following software on the controlling PC:

- Section 4.6.1, "R&S VISA", on page 19
- Section 4.6.2, "R&S NRP-Toolkit", on page 20

The installation of the other software packages is optional.

### 4.6.1 R&S VISA

A driver software that supports I/O communication functions is known as VISA software library. You can use any VISA software library, but we recommend that you use the R&S VISA.

► Download the R&S VISA for different operating systems at www.rohde-schwarz.com/rsvisa.

R&S VISA allows fast communication with the sensor module. It includes a trace tool for communication analysis, a testing tool for connection check, and a configuration tool for the definition of resources.

## 4.6.2 R&S NRP-Toolkit

Before you start using an R&S sensor or sensor module, we recommend installing the latest R&S NRP-Toolkit.

The R&S NRP-Toolkit is the basic software package that supplies low-level drivers and tools for all R&S sensors and sensor modules. The components of the R&S NRP-Toolkit depend on the operating system.

### 4.6.2.1 Versions and downloads

The R&S NRP-Toolkit is available for:

- Microsoft Windows® operating system, as listed in Section 4.6.2.2, "System requirements", on page 20
- macOS

The latest versions for Windows and macOS are available at:

www.rohde-schwarz.com/software/nrpm

To obtain an R&S NRP-Toolkit for other operating systems, contact the Rohde & Schwarz customer support, see Section 12.6, "Contacting customer support", on page 178.

### 4.6.2.2 System requirements

Hardware requirements:

- Desktop computer or laptop, or an Intel-based Apple Mac
- LAN interface and equipment for setting up a LAN connection.
  See Section 6.3.4, "Using the LAN connection", on page 42.

For supported Microsoft Windows versions, see the release notes.

### 4.6.2.3 R&S NRP-Toolkit for Windows

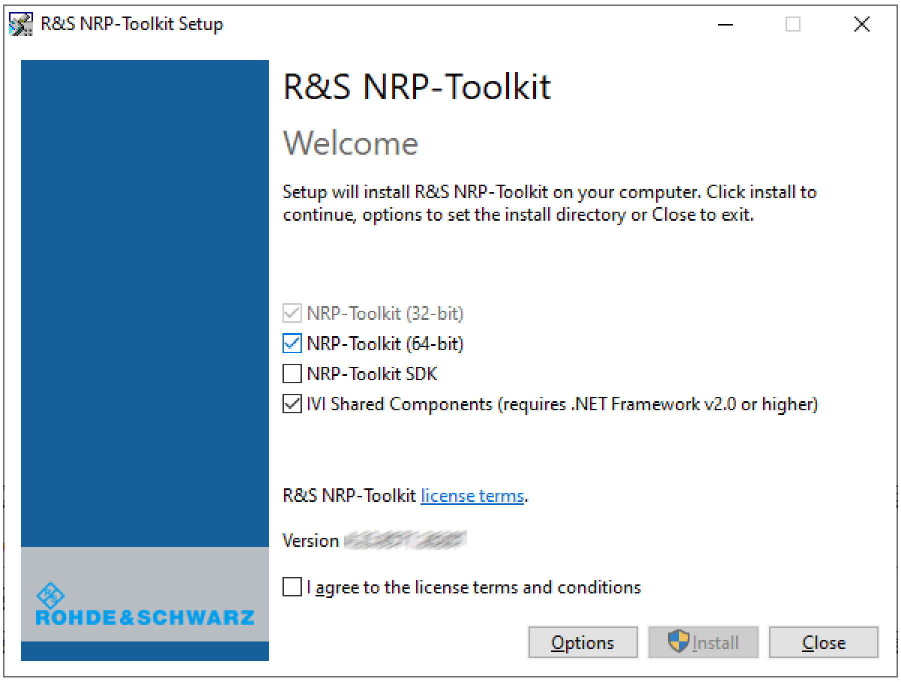
The R&S NRP-Toolkit installer for Windows-based systems contains the components described in the release notes.

**To install the R&S NRP-Toolkit**

1. Start the R&S NRP-Toolkit installer on the Windows-based computer.

   In the "NRP-Toolkit Setup" dialog, the correct R&S NRP-Toolkit version for your operating system, 32-bit or 64-bit, is already selected.

2. Enable the components that you want to install.
   - "NRP-Toolkit (SDK)"
     The software development kit (SDK) provides programming examples for the R&S sensor modules.
     See Section 11, "Programming examples", on page 159.
   - "IVI Shared Components"
     Installs the USBTMC driver. Enabled by default because the installation is recommended.
     See also Table 9-1




3. Accept the license terms to continue with the installation.

4. Click "Next" and complete the installation process.

**To uninstall the R&S NRP-Toolkit**

Use the Windows functionality for removing apps and features. The R&S NRP-Toolkit itself has no uninstall functionality.

### Components of the R&S NRP-Toolkit

Access: "Start" > "NRP-Toolkit"

The following tools are part of the R&S NRP-Toolkit for Windows.

#### Configure Network Sensor

Useful if you have trouble establishing a LAN connection with a LAN sensor module.

The tool provides the following functions:

- Configuring the network settings by temporarily using a USB connection.
- Discovering the sensor modules that have been configured via the zeroconf (APIA) protocol.

The tool comes with a guide (PDF) that is also available in the "Start" menu. The guide explains the network setup.

#### Firmware Update

Installs new firmware on the sensor module.

See Section 8, "Firmware update", on page 69.

#### NRP Uncertainty Calculator

Determines the expanded measurement uncertainty. The tool comes with a manual (PDF) that is also available in the "Start" menu.

#### NRP Version Display

Displays version information of all installed, power measurement-relevant software packages.

#### S2P Wizard

S-parameter compensation is not supported by the R&S NRPM3 sensor modules.

#### S-Parameter Update Multi

S-parameter compensation is not supported by the R&S NRPM3 sensor modules.

#### Terminal

Low-level communication program for sending commands to the sensor module.

### 4.6.3 R&S Power Viewer

The R&S Power Viewer is an interactive power measurement software application from Rohde & Schwarz for measurements and evaluation of results with the sensor module.

The R&S Power Viewer is a separate standalone installation package. The installation package is provided on the Rohde & Schwarz website at:

www.rohde-schwarz.com/software/nrpm

As a prerequisite, the R&S Power Viewer requires the following software installed:

- R&S VISA
- R&S NRP-Toolkit

With the R&S Power Viewer software, the user manual is installed.

### 4.6.4 Programming examples for customer-specific applications

Rohde & Schwarz provides various programming examples containing:

- Programming examples in C/C++ or Python source code for VISA communication protocols
- Project and auxiliary files

The programming examples are included in the SDK (software development kit) of the R&S NRP-Toolkit. You can select the SDK during installation, see "To install the R&S NRP-Toolkit" on page 21.

If you install the optional software development kit (SDK) of the R&S NRP-Toolkit, programming examples are provided. See Section 4.6.2, "R&S NRP-Toolkit", on page 20.

Under Windows, these examples are installed under:

`C:\ProgramData\Rohde-Schwarz\NRP-Toolkit-SDK\examples`

# 5 R&S NRPM tour

The following chapters introduce the main hardware components of the R&S NRPM OTA power measurement solution.

## 5.1 R&S NRPM3(N) sensor modules

The R&S NRPM3(N) three-channel sensor module processes the measured values from up to three antenna modules in three separate channels.

This chapter provides an overview of the available connectors and LEDs of the R&S NRPM3(N) sensor modules. Figure 5-1 shows the LAN sensor module on the left, and the USB sensor module on the right.

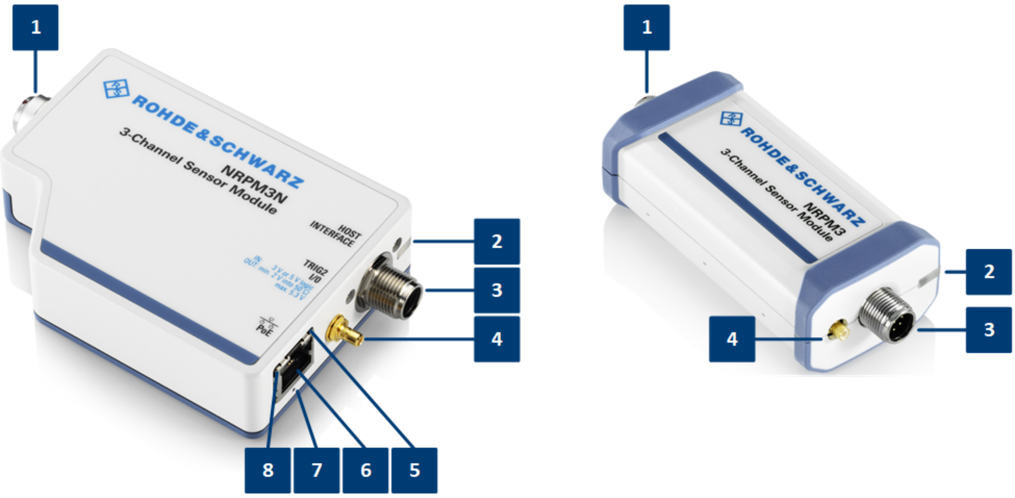



***Figure 5-1: R&S NRPM3N and R&S NRPM3***

1 = Antenna connector, see "Antenna connector (1)" on page 24
2 = Status LED, see "Status LED (2)" on page 25
3 = Host interface connector, see "Host interface connector (3)" on page 25
4 = Trigger I/O connector, see "Trigger I/O connector (4)" on page 25
5 = Network status LED, see "Network status LED (5)" on page 26
6 = LAN connector, see "LAN PoE interface (6)" on page 26
7 = LAN reset button, see "LAN reset (7)" on page 26
8 = Power over Ethernet status LED, see "Power over Ethernet status LED (8)" on page 26

**Antenna connector (1)**
Multipole antenna connector for connecting the
- R&S NRPM3(N) to the interface module R&S NRPM-Z3.
- R&S NRPM3(N) to the filtered cable feedthrough module R&S NRPM-ZD3 with the interface cable R&S NRPM-ZKD3.

**Note:** Measurements with R&S NRPM3N LAN sensor modules require that you use the latest version of the R&S NRPM-ZKD3 interface cable (1436.2984.02).

**Status LED (2)**

| | Color | Indication | State |
|---|---|---|---|
| ○ | White | Steady | Idle<br>The sensor module performs no measurement and is ready for use. |
| | White | Fast flashing | Firmware update or reboot is in progress. When the firmware update or reboot is finished, the LED changes to glowing white steadily, indicating the idle state. |
| | White | Slow flashing | Sanitizing is in progress. |
| | Yellow | Steady | Waiting for trigger state. |
| | Green | Steady | Measurement is running. |
| | Turquoise blue | Steady | Zeroing is in progress. |
| | Red | Slow flashing | Static error<br>You can query the type of the error with `SYSTem:SERRor?` on page 113. |
| | Red | Fast flashing | Critical static error<br>You can query the type of the error with `SYSTem:SERRor?` on page 113.<br>**Note:** If a critical error occurs after a firmware update, the update was not successful. Perform the firmware update again.<br>See Section 12.3, "Problems during a firmware update", on page 174. |

**Host interface connector (3)**

The host interface connector is used for establishing a connection between the sensor module and the USB host. For the connection, you need an external cable.

See:

- Section 4.5, "Hardware requirements", on page 18
- Section 6.3.3, "Using the USB connection", on page 39

The host interface connector also contains the trigger1 connection for input or output of a trigger signal, e.g., to synchronize several sensor modules in trigger sender or in receiver mode.

For information on how to assign the signals to the ports, see Section 10.10, "Configuring the trigger", on page 146.

**Trigger I/O connector (4)**

The trigger I/O is a connector of SMB type.

You can use this interface as an input for an external trigger signal.

Optionally, you can use it as an output, e.g. to synchronize several sensor modules with the sensor working in the trigger sender mode, see "Host interface connector (3)" on page 25.

For information on how to assign the signals to the ports, see Section 10.10, "Configuring the trigger", on page 146.

**Network status LED (5)**
Indicates whether the LAN connection to the network is established.

| Indication | | State |
|---|---|---|
| ● | Green | The R&S NRPM3N sensor module is connected to the network.<br>The IP address assigned by the DCHP or manually is valid. |
| ● | Red | The R&S NRPM3N is not connected to the network properly.<br>Either the connection is erroneous or the assigned IP address of the sensor module is not valid. |

**LAN PoE interface (6)**
R&S NRPM3N LAN sensor modules only

RJ-45 connector to connect the Ethernet interface of a R&S NRPM3N sensor module to a local area network (LAN).

**Note:** Ethernet interface requires PoE (power over Ethernet). This Ethernet interface provides the electrical power by power over Ethernet (PoE) for the sensor modules. PoE is mandatory, when using the LAN interface, since the USB port does not provide sufficient power. See Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.

**LAN reset (7)**
Button for resetting the Ethernet connection parameters of the R&S NRPM3N sensor module to its default values.

**Power over Ethernet status LED (8)**
Indicates whether the R&S NRPM3N sensor modules is powered over PoE.

| Indication | | State |
|---|---|---|
| ● | Green | The interface provides PoE. The sensor module is powered. |
| ○ | Not illuminated | PoE power is not applied. |

## 5.2 R&S NRPM-A90 and R&S NRPM-A90D antenna modules

This section introduces the antenna modules of the R&S NRPM OTA power measurement solution.

For more information, see the specifications document.

**R&S NRPM-A90**

Single polarized antenna module with integrated diode detector

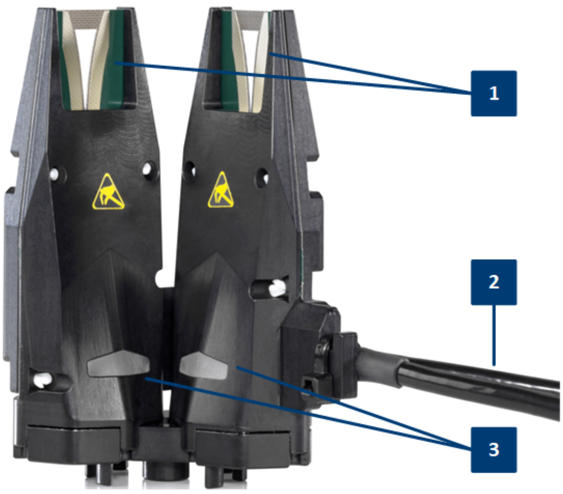

1 = PCB (printed circuit board)

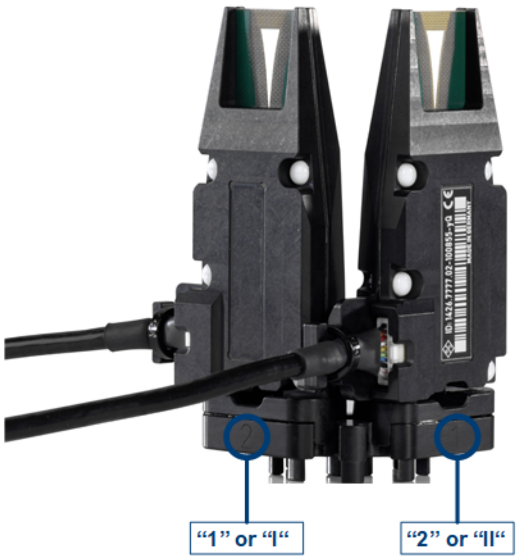
2 = Interface cable

3 = Signaling LED

**R&S NRPM-A90D**

Dual polarized antenna module with integrated diode detectors



1 = PCBs (printed circuit boards)
2 = Interface cables
3 = Signaling LEDs

To distinguish the feeds, the carrier of the R&S NRPM-A90D antenna module is labeled on the back with the corresponding letters "1" and "2", or "I" and "II".

An R&S NRPM-A90D module occupies two channels on the R&S NRPM3.

The R&S NRPM-A90/-A90D antenna modules are designed to work with the R&S NRPM3(N) sensor modules.

Electrostatically sensitive components. Follow the instructions described in "To prevent antenna damage" on page 17.

R&S NRPM OTA power measurements with the antenna modules R&S NRPM-A90 and R&S NRPM-A90D require at least FW version NRPM3_18.05.08.03.rsu or NRPM3N_18.05.08.03.rsu on the sensor module. Earlier FW versions support only the predecessor antenna modules R&S NRPM-A66.

**Antenna module cable (2)**
Cable firmly connected to the antenna modules for connection to the R&S NRPM-ZD3 feedthrough or the R&S NRPM-Z3 interface modules.

**Note:** The contact durability of these connectors is limited, therefore note the plug-in cycles specified in the specifications document.

**Signaling LED (3)**
LED for signaling purposes.

You can use the LED for mapping between the antenna module location and the sensor module channel, or for own signaling purposes.

To turn on the LED, use the SCPI command SYSTem:LED:CHANnel<Channel>:COLor on page 109. The LED color is blue.

## 5.3 R&S NRPM-ZD3 feedthrough module

The R&S NRPM-ZD3 filtered cable feedthrough module combines up to three antenna modules to one connector. From the cable feedthrough module, three independent antenna measurements are led to the R&S NRPM3(N) sensor module over the R&S NRPM-ZKD3 interface cable.

Measurements with R&S NRPM3N LAN sensor modules require that you use the latest version of the R&S NRPM-ZKD3 interface cable (1436.2984.02).

The filtered cable feedthrough is developed for use with a shielded RF shielded box, e.g. the R&S CMQ200.

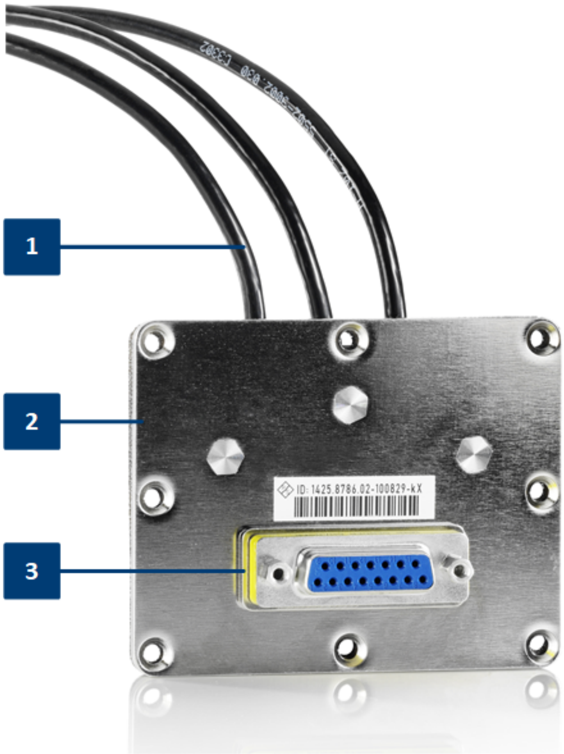



*Figure 5-2: The R&S NRPM-ZD3 feedthrough module*

1 = Antenna module cable connectors
2 = Cable feedthrough module
3 = Sensor module cable connector

**Antenna module cable connectors (1)**
Micro miniature connectors (10 pin) for connecting up to three antenna module cables.

**Filtered cable feedthrough module (2)**
R&S NRPM-ZD3 filtered cable feedthrough for combining three antenna module cables to one sensor module cable R&S NRPM-ZKD3.

**Sensor module cable connector (3)**
SUB-D connector (15 pin) for connecting to the sensor modules with the interface cable R&S NRPM-ZKD3.

## 5.4 R&S NRPM-Z3 interface module

For direct connection inside an EM controlled environment, you can use the R&S NRPM-Z3 interface module. Plugged directly to the R&S NRPM3(N) three channel sensor module, the R&S NRPM-Z3 interface module can host up to three antenna modules without additional cables required.

This section introduces the interface module for connecting, e.g. three antenna module cables for OTA power measurements in an EM-controlled environment, e. in an RF test chamber.

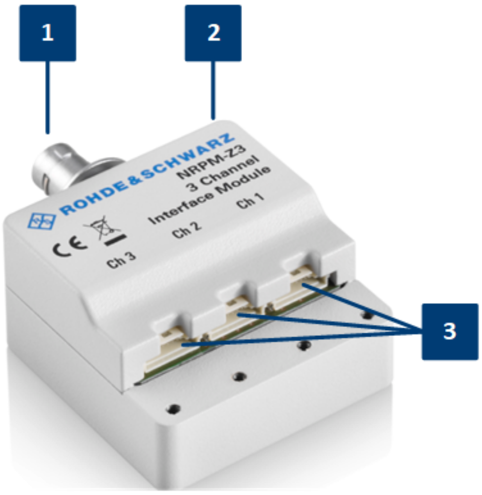



*Figure 5-3: The R&S NRPM-Z3 interface module*

1 = Connector to sensor module
2 = Interface module
3 = Antenna module cable connectors

**Connector to sensor module (1)**
16-pin push-pull connector for connecting to the sensor module.

**Interface module (2)**
R&S NRPM-Z3 three channel interface module to pass up to three antenna module cables to one R&S NRPM3(N) sensor module.

**Antenna module cable connectors (3)**
Micro miniature connectors (10 pin) for connecting the antenna module cables.

## 5.5 R&S NRPM-Z3 connected to the R&S NRPM3


*Figure 5-4: R&S NRPM-Z3 connected to R&S NRPM3*

1 = R&S NRP-ZKU
2 = R&S NRPM3
3 = R&S NRPM-Z3
4 = Strain relieve
5 = Antenna module cables

**Strain relieve (4)**
Strain relieve for the antenna module cable connections.

**Antenna module cables (5)**
Cables firmly connected to the antenna modules for connection to the R&S NRPM-Z3 interface module or the R&S NRPM-ZD3 feedthrough interface modules.

# 6 Setting up a measurement

This section points out important aspects to consider when setting up an R&S NRPM OTA power measurement. It shows some test setup examples and brief instructions on how to connect the components. You can also find references to the product page and the user manual of the RF shielded box R&S CMQ200 or an RF test chamber.



## 6.1 Test setup examples

The following section shows some test setups examples with an RF shielded box and within an RF test chamber. The main difference is that the sensor module is either inside, or outside the EM-controlled test environment:

- **RF shielded box**
  The sensor module is outside the RF shielded box, connected to the antenna modules via the feedthrough module (R&S NRPM-ZD3) and the interface cable (R&S NRPM-ZKD3).
- **RF test chamber**
  The sensor module is inside an RF test chamber, directly connected to the antenna modules via the interface module (R&S NRPM-Z3).

See also the application note 1GP118.

Always operate the antenna modules in an environment that is protected against electromagnetic interference.

The described examples refer to measurements performed with R&S Power Viewer, which allows you to measure the readings of up to four R&S NRPM3(N) sensor modules (12 antenna module channels) at a time. This number corresponds to 12 single or 6 dual polarized antenna modules. Technically, more are possible, i.e. you can select any number of antenna modules for your measurement.

Test setups with R&S NRPM3N LAN sensor modules and the R&S NRPM-ZKD3 interface cables for connection to a RF shielded box, require that you use the latest version of the interface cable (1436.2984.02).

### Single antenna module solution

The base configuration with one antenna module measures the power of the incident wave from the DUT to the antenna module, e.g. to calibrate the output power of your DUT.

**Example:**

Setup with one single polarized R&S NRPM-A90 antenna module installed in an RF shielded box (feedthrough module):

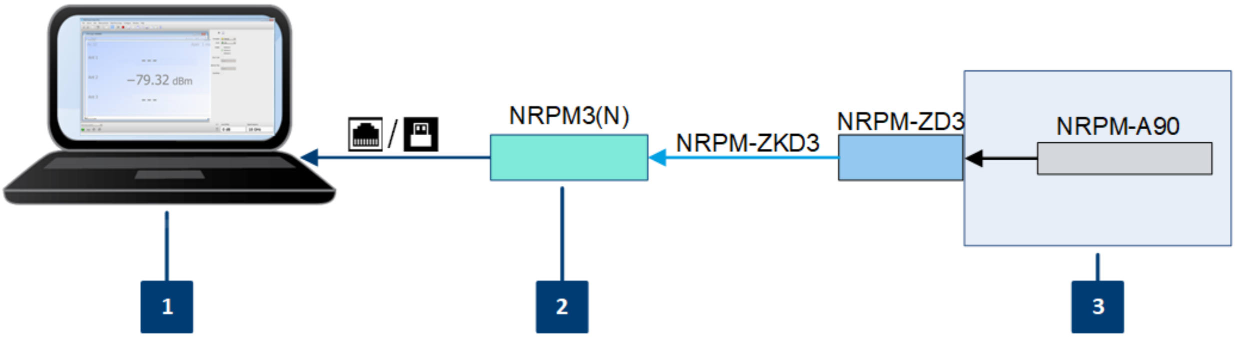



*Figure 6-1: One R&S NRPM-A90 in an RF shielded box*

1 = Controller PC
2 = Sensor module
3 = RF shielded box

### Multiple spatially distributed antenna modules

With several antenna modules distributed in an area, you can test the beamforming function of a DUT. The more antenna modules are installed, the higher is the measurement accuracy during beamforming tests. In addition, you can derive matrices for swiveling the beam of the antenna module around two axes.

**Example:**

Setup with multiple single polarized R&S NRPM-A90 antenna modules in an RF shielded box (feedthrough modules):

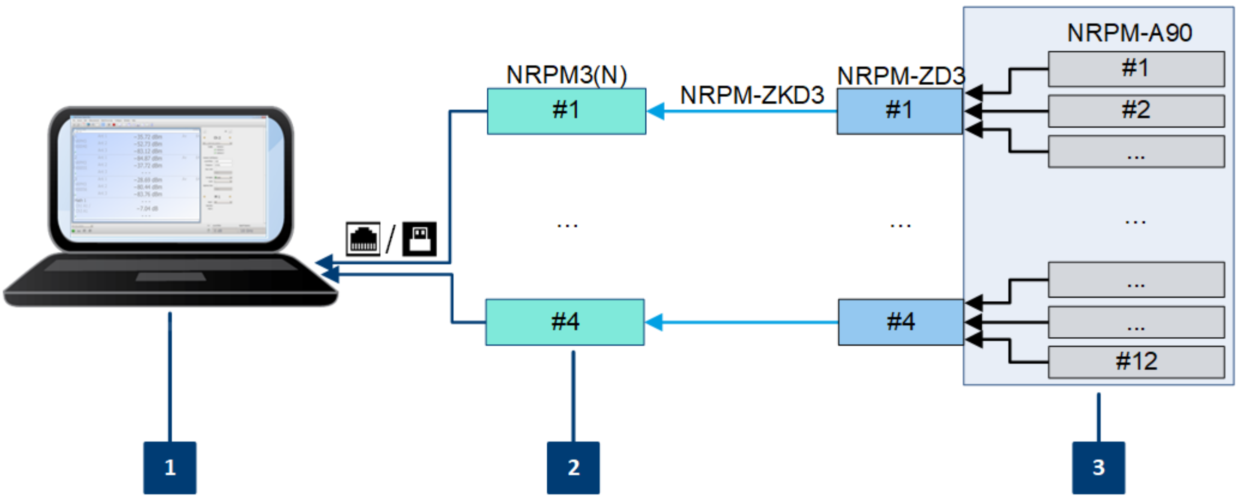



*Figure 6-2: Multiple R&S NRPM-A90 in an RF shielded box*

1 = Controller PC
2 = Sensor modules
3 = RF shielded box

**Example:**

Setup with multiple single polarized R&S NRPM-A90 antenna modules in an RF test chamber (interface modules):

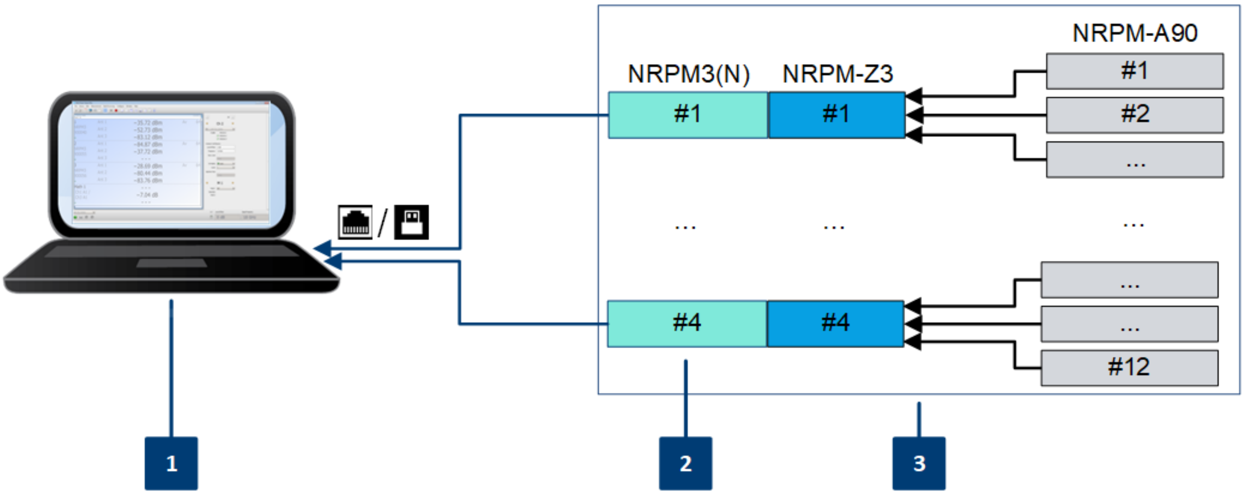



*Figure 6-3: Multiple R&S NRPM-A90 in an RF test chamber*

1 = Controller PC
2 = Sensor modules
3 = RF test chamber

**Example:**

Setup with dual polarized R&S NRPM-A90D antenna modules in an RF shielded box with feedthrough modules:

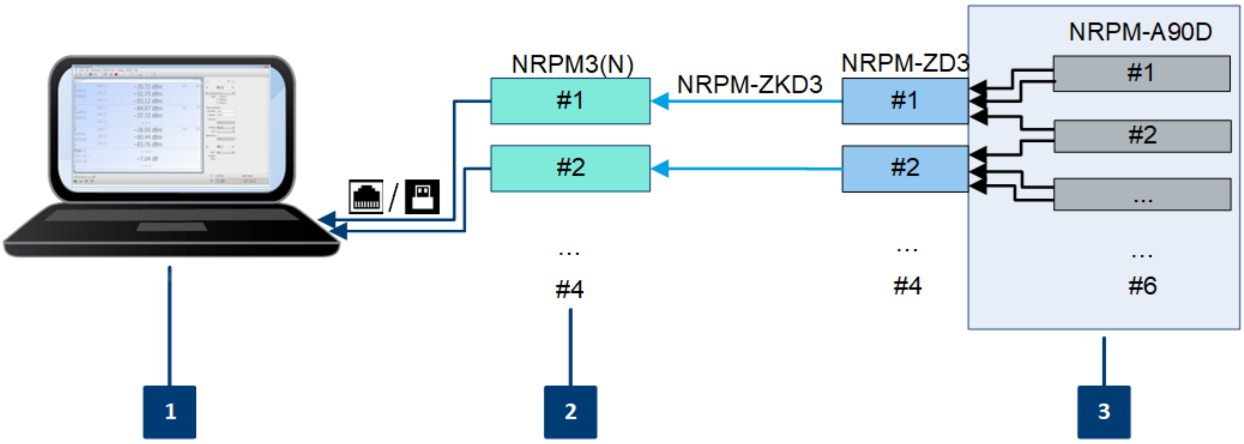



*Figure 6-4: Setup with multiple R&S NRPM-A90D in an RF shielded box*

1 = Controller PC
2 = Sensor modules
3 = RF shielded box

**Note:** Since one dual polarized antenna module allocates two channels of the sensor module, you can use a maximum of three antenna modules with two sensor modules. If your test setup requires more antenna modules, use additional sensor modules. In this test setup, you can measure the readings of up to six antenna modules with four sensor modules.

To set up a measurement with R&S NRPM-A90D dual polarized antenna modules in an RF test chamber, use the corresponding modules, as shown above.

## 6.2 R&S CMQ200 shielding cube

The R&S CMQ200 Shielding Cube, in this manual referred to as RF shielded box, enables reliable and reproducible measurements when a controlled EM test environment is needed.

As the R&S CMQ200 is a stand-alone product of Rohde & Schwarz, this section does not describe the box and measurement setups in detail. If you perform an OTA measurement with the box, you find the necessary information at:

- www.rohde-schwarz.com/product/cmq200, providing an overview of the R&S CMQ200 RF shielded box with the available models and the variety of antenna holders and feedthrough options.
- www.rohde-schwarz.com/manual/cmq200, providing the user manual, which describes the hardware, the options and the accessories, and how to install and configure the antenna modules.

- www.rohde-schwarz.com/brochure-datasheet/cmq200, providing the product brochure, which deals with specific characteristics, and contains the technical specifications and ordering information.

## 6.3 Connecting an R&S NRPM OTA power measurement

To start up an R&S NRPM OTA power measurement, it is assumed that the following conditions are met:

- All required hardware is available and ready for use, see Section 4.6, "Software requirements and installation", on page 19.
- The firmware version of the sensor module has release 2.00 or later, required for R&S NRPM OTA power measurements with the antenna modules R&S NRPM-A90 or R&S NRPM-A90D.
  How to: see Section 8, "Firmware update", on page 69.
- The software is installed on the controller PC.
  How to: see Section 4.6, "Software requirements and installation", on page 19.
- The (DUT) is installed and ready for operation.
- The R&S NRPM OTA power measurement components are powered off.



### 6.3.1 Connecting the RF frontend

The following steps describe how to connect the antenna modules and a sensor module in both, an RF shielded box or an RF test chamber.

#### 6.3.1.1 Connecting the RF frontend in an RF shielded box

When you are working with the dual-polarized antenna modules R&S NRPM-A90D, notice the feeds of the vertical and horizontal antenna modules. You can find out the alignment with the identification numbers "1" or "I" (vertical) and "2" or "II" (horizontal) on the carrier of the antenna modules.

**Required equipment**

- RF shielded box, e.g. the R&S CMQ200
- Suitable antenna ring, see the accessories available for the corresponding RF shielded box
- One or more antenna modules, e.g. R&S NRPM-A90D or R&S NRPM-A90

- R&S NRPM-ZD3 (2) mounted in the RF shielded box
- R&S NRPM-ZKD3 interface cable.
- R&S NRPM3(N) (1) sensor module

**To connect the RF frontend in the RF shielded box**

1. In the RF shielded box, install the antenna ring.
2. **NOTICE!** Risk of antenna damage. Observe "To prevent antenna damage" on page 17.

   Mount the antenna modules.
   For connecting options, see the user documentation of the RF shielded box you are using, e.g. as referred to in Section 6.2, "R&S CMQ200 shielding cube", on page 35.
3. **NOTICE!** Risk of cable breakage. The connectivity of the antenna cable ends is sensitive, and therefore the contact durability of the connection is limited.
   Do not connect and disconnect the cables to the feedthrough board frequently.

   Connect each antenna module cable to the antenna module cable connectors of the feedthrough module R&S NRPM-ZD3 (2).
4. Outside the RF shielded box, make sure that the sensor module is powered off, i.e. not yet connected to the power sourcing interface, see Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.
5. To connect the R&S NRPM3(N) (1) sensor module to the feedthrough module R&S NRPM-ZD3 (3):
   a) Connect the 15-pin Sub-D connector of the interface cable R&S NRPM-ZKD3 to the R&S NRPM-ZD3 (3) feedthrough module.
   b) Observe the guide gap of the sensor connector to ensure correct alignment to the mating antenna connector of the sensor module.
   c) Insert the sensor connector of the interface cable straight into the antenna connector of the sensor module.
6. Continue with Connecting to the controller PC.

**To disconnect the R&S NRPM-ZKD3 from the sensor module**

1. Disconnect the power sourcing interface of the sensor module.
2. Pull the sensor connector of the cable from the antenna connector of the sensor module. Take care not to tilt it.

### 6.3.1.2 Connecting the RF frontend in an RF test chamber

When you are working with the dual-polarized antenna modules R&S NRPM-A90D, notice the feeds of the vertical and horizontal antenna modules. You can find out the alignment with the identification numbers "1" or "I" (vertical) and "2" or "II" (horizontal) on the carrier of the antenna modules.

**Required equipment**

- Suitable antenna ring, see the accessories available for the R&S NRPM3(N) OTA power measurement solution
- One or more antenna modules, e.g. R&S NRPM-A90D or R&S NRPM-A90
- NRPM-Z3 (3)
- R&S NRPM3(N) (1) sensor module

**To connect RF frontend with the sensor module in an RF test chamber**

1. **NOTICE!** Risk of antenna damage. Observe "To prevent antenna damage" on page 17.
   In the RF test chamber, mount the antenna modules.
   For information on the connecting options, refer to the documentation of the antenna equipment.
2. On the interface module NRPM-Z3 (3), dismount the strain relieve NRPM-Z3 (4) using a torx screwdriver TX8.
3. **NOTICE!** Risk of broken cables. The connectivity of the antenna cable ends is sensitive, and therefore the contact durability of the connection is limited.
   Do not connect and disconnect the cables to the interface module frequently.
   Connect each antenna module cable to the antenna module cable connectors of the interface module.
4. Mount the strain relieve of the interface module.
5. To connect the R&S NRPM-Z3 interface module to the R&S NRPM3(N) sensor module, see R&S NRPM-Z3 connected to R&S NRPM3:
   a) Make sure that the sensor module is powered off, i.e. not yet connected to the power sourcing interface, see Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.
   b) Insert the 16-pin sensor connector of the R&S NRPM-Z3 interface module straight into the antenna connector of the R&S NRPM3(N). Take care that the guide gap of the sensor connector fits to the guide lug of the mating antenna connector of the sensor module.
6. Continue with Connecting to the controller PC.

**To disconnect the R&S NRPM-Z3 from the sensor module**

1. Disconnect the power sourcing interface of the sensor module.

2. Pull the sensor connector of the interface module from the antenna connector of the sensor module. Take care not to tilt it.

### 6.3.2 Connecting to the controller PC

The controlling host of the R&S NRPM OTA power measurement solution is a computer, using a supported software for controlling the R&S NRPM3(N) sensor modules, see Section 4.6, "Software requirements and installation", on page 19.

You can connect the sensor module using the LAN interface, when working with the R&S NRPM3N. To connect the R&S NRPM3, use the USB host interface.

To connect the sensor module to the controller PC, see:

- Section 6.3.3, "Using the USB connection", on page 39
- Section 6.3.4, "Using the LAN connection", on page 42

### 6.3.3 Using the USB connection

You can connect all R&S NRPM3(N) sensor modules to the USB interface of a computer. The high-speed USB connection supports control of all R&S NRPM3(N) types. It also provides the power supply for the R&S NRPM3 sensor modules.

USB power is not sufficient for R&S NRPM3N sensor modules. See Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.

#### 6.3.3.1 Simple USB connection

**Required equipment**

- R&S NRPM3(N)
- R&S NRP-ZKU
- Controller PC with USB host interface and installed VISA driver or R&S NRP-Toolkit and R&S Power Viewer Mobile

**Setup**

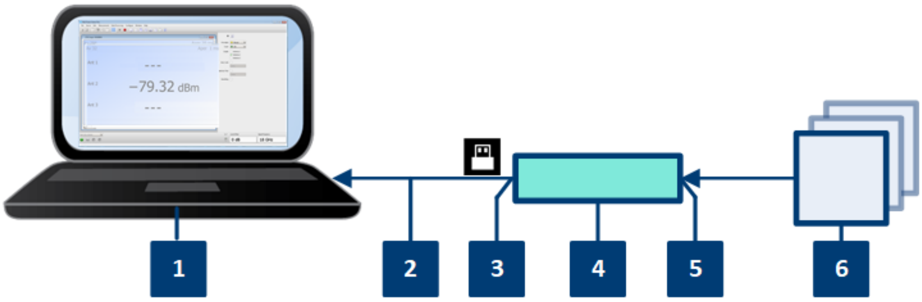



*Figure 6-5: Setup with an R&S NRP-ZKU*

1 = Controller PC
2 = R&S NRP-ZKU
3 = USB host interface connector
4 = R&S NRPM3 sensor module
5 = Antenna connector
6 = Antenna module(s)

#### To connect the R&S NRPM3 sensor module and the controller PC

Setup as shown in Figure 6-5.

1. Use the cable provided for the setup to connect to the R&S NRPM3 host interface, see Section 4.5, "Hardware requirements", on page 18.
   a) Insert the screw-lock cable connector of the R&S NRP-ZKU into the host interface R&S NRPM3 (2) connector of the sensor module.
   b) Tighten the union nut manually.
2. Connect the R&S NRP-ZKU USB connector to the controller PC.

#### To disconnect the R&S NRP-ZKU cable from the sensor module

1. Loosen the union nut of the screw-lock cable connector.
2. Remove the cable.

### 6.3.3.2 Sensor hub R&S NRP-Z5

The R&S NRP-Z5 sensor hub (high-speed USB 2.0) can host up to four sensor modules and provides simultaneous external triggering to all connected sensors.

#### Required equipment

- 1 to 4 R&S NRPM3 sensor module
- 1 NRP-ZK6 per sensor
- R&S NRP-Z5 sensor hub with external power supply unit and USB cable
- Controller PC with USB host interface and installed VISA driver, R&S NRP-Toolkit and R&S Power Viewer Mobile

### Setup

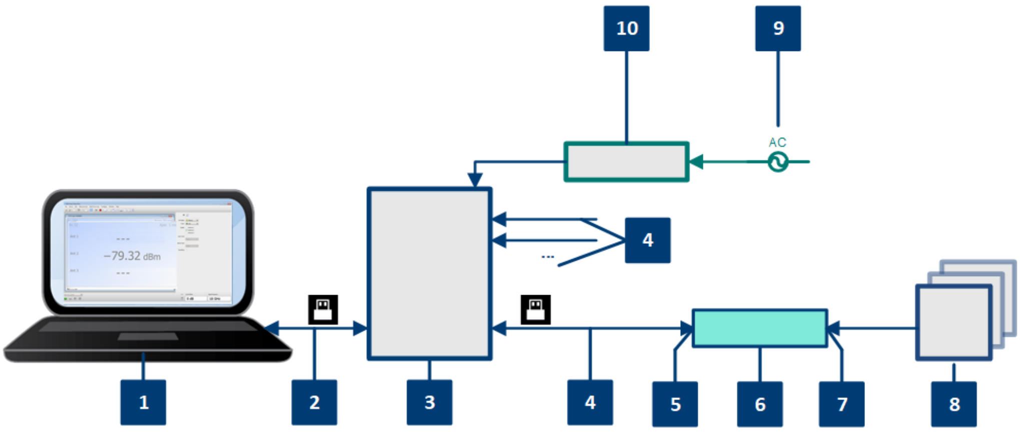



*Figure 6-6: Setup with an R&S NRP-Z5 sensor hub*

1 = Controller PC
2 = USB cable
3 = R&S NRP-Z5 sensor hub
4 = NRP-ZK6 cables
5 = USB host interface connector
6 = R&S NRPM3 sensor module
7 = Antenna connector
8 = Antenna module(s)
9 = AC power supply
10 = External power supply unit

#### To connect a setup with several sensor modules using the R&S NRP-Z5

Setup as shown in Figure 6-6.

1. Connect the R&S NRP-Z5 to the computer.
2. Connect the NRP-ZK6 to the power sensor, see "To connect the R&S NRPM3 sensor module and the controller PC" on page 40.
3. Connect the USB connector of the NRP-ZK6 to the R&S NRP-Z5 sensor hub.
4. If necessary, connect further sensor modules to the sensor hub accordingly.
5. Connect the external power supply unit to the R&S NRP-Z5 and to the mains.
6. Establish the connection of the antenna modules as described in Section 6.3.1, "Connecting the RF frontend", on page 36.
7. On the computer, start a software application to execute the measurement, see Section 7, "Performing measurements", on page 48.

### 6.3.4 Using the LAN connection

Requires the R&S NRPM3N LAN sensor module with networking capabilities.

Depending on the available equipment, you have several options to connect a R&S NRPM3N LAN sensor module to the controller PC.

**Setup with a PoE Ethernet switch**

To connect the R&S NRPM3N to a LAN, use a PoE switch, e.g. the R&S NRP-ZAP1. This switch provides the power supply and control for the antenna modules.

**Required equipment**

- 1 R&S NRPM3N sensor module
- 2 RJ-45 Ethernet cables,
  To avoid any impact, use at least category 6 STP cables for the LAN connection, see Section 4.5, "Hardware requirements", on page 18.
- 1 Ethernet switch, supporting PoE power delivery, e.g., R&S NRP-ZAP1
- Controller PC with LAN interface and installed VISA driver or R&S NRP-Toolkit and R&S Power Viewer Mobile

**Setup**

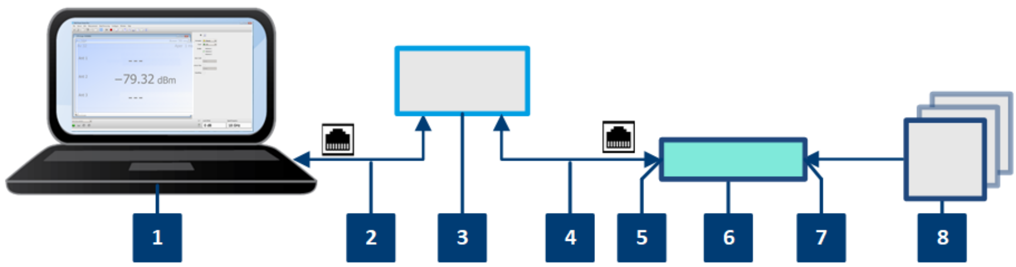



*Figure 6-7: Setup with a PoE Ethernet switch*

1 = Controller PC
2, 4 = RJ-45 Ethernet cables
3 = Ethernet switch
5 = LAN connector (RJ-45 Ethernet PoE interface)
6 = R&S NRPM3N LAN sensor module
7 = Antenna connector
8 = Antenna module(s)

**To connect the R&S NRPM3N to the controller PC with the PoE Ethernet switch**

1. **NOTICE!** Risk of sensor damage. Only use PoE power sourcing equipment (PSE) as described in Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.

   Connect the LAN PoE interface (5) of the sensor module to the Ethernet switch.

2. Connect the controller PC to the Ethernet switch.
3. On the controller, establish a connection between the sensor module and the network, see Section 6.3.5, "Connecting to the network", on page 45.

#### Setup with a PoE injector and a non-PoE Ethernet switch

#### Required equipment

- 1 R&S NRPM3N sensor module
- 3 RJ-45 Ethernet cables
  To avoid any impact, use at least category 6 STP cables for the LAN connection, see Section 4.5, "Hardware requirements", on page 18.
- 1 PoE injector
- 1 non-PoE Ethernet switch
- Controller PC with LAN interface and installed VISA driver or R&S NRP-Toolkit and R&S Power Viewer Mobile
- Controller PC

#### Setup

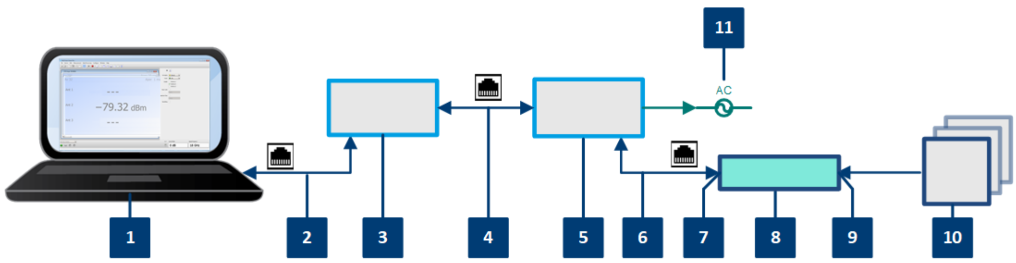



*Figure 6-8: Setup with a PoE injector and a non-PoE Ethernet switch*

1 = Controller PC
2,4,6 = RJ-45 Ethernet cables
3 = Non-PoE Ethernet switch
5 = PoE injector
7 = LAN connector (RJ-45 Ethernet PoE interface)
8 = R&S NRPM3N LAN sensor module
9 = Antenna connector
10 = Antenna module(s)
11 = AC power supply

#### To connect the R&S NRPM3N to the controller PC with the PoE injector and a non-PoE Ethernet switch

1. **NOTICE!** Risk of sensor damage. Only use PoE power sourcing equipment (PSE) as described in Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.

   Connect the LAN PoE interface (5) of the sensor module to the PoE injector.
2. Connect the PoE injector to the AC supply (mains).
3. Connect the input of the PoE injector to the non-PoE Ethernet switch.

4. Connect the controller PC to the non-PoE Ethernet switch.
5. On the controller, establish a connection between the sensor module and the network, see Section 6.3.5, "Connecting to the network", on page 45.

### Setup with a PoE injector

### Required equipment

- 1 R&S NRPM3N sensor module
- 2 RJ-45 Ethernet cables
  To avoid any impact, use at least category 6 STP cables for the LAN connection, see Section 4.5, "Hardware requirements", on page 18.
- 1 PoE injector
- Controller PC with LAN interface and installed VISA driver or R&S NRP-Toolkit and R&S Power Viewer Mobile

### Setup

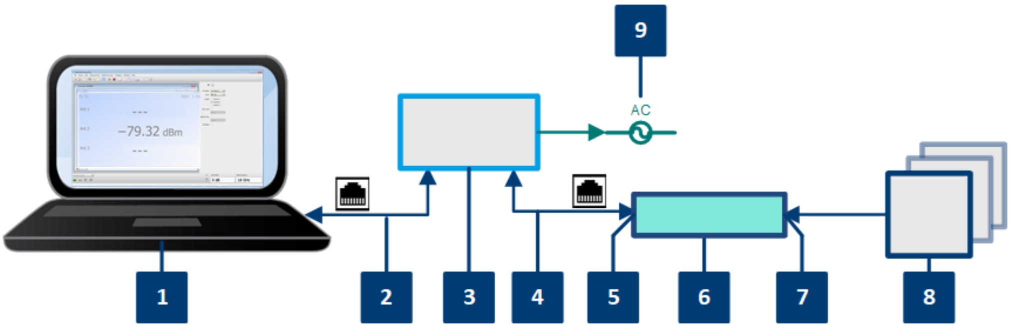



*Figure 6-9: Setup with a PoE injector*

1 = Controller PC
2, 4 = RJ-45 Ethernet cable
3 = PoE injector
5 = LAN connector (RJ-45 Ethernet PoE interface)
6 = R&S NRPM3N R&S NRPM3N LAN sensor module
7 = Antenna connector
8 = Antenna module(s)
9 = AC power supply

### To connect the R&S NRPM3N to the controller PC with the PoE injector

1. **NOTICE!** Risk of sensor damage. Only use PoE power sourcing equipment (PSE) as described in Section 4.4, "Powering the R&S NRPM3(N) sensor module", on page 18.
   Connect the LAN PoE interface (5) of the sensor module to the PoE injector.
2. Connect the PoE injector to the AC supply (mains).
3. Connect the controlling host to the input of the PoE injector.

4. On the controller, establish a connection between the sensor module and the network.

### 6.3.5 Connecting to the network

There are two methods to establish a network connection:

- The R&S NRPM3N LAN sensor module and controlling host are connected to a common network (infrastructure network).
- The R&S NRPM3N LAN sensor module and controlling host are connected only over the switch (peer-to-peer network).

For both connections, the common network or the peer -to-peer connection over the switch, you address the sensor module as follows:

- Section 6.3.5.1, "Using hostnames", on page 46
- Section 6.3.5.2, "Assigning the IP address", on page 47

**To set up a network Ethernet connection**

1. Connect the sensor module as described in Section 6.3.4, "Using the LAN connection", on page 42.
   By default, the R&S NRPM3N uses dynamic TCP/IP configuration (DHCP) and obtains the address information automatically.
   If both network status LEDs light up in green color, the connection of the R&S NRPM3N to the network is established successfully.
   **Note:** Establishing a connection can take up to 2 minutes.
2. If the network status LEDs indicate another state, no connection is possible. For reasons and possible solutions, see:
   - "Power over Ethernet status LED (8)" on page 26
   - "Network status LED (5)" on page 26
   - "To check the network connection" on page 45

**Troubleshooting for peer-to-peer connections**

**To check the network connection**

1. Check that the assigned IP address of the used network adapter starts with `169.254`. The IANA (Internet assigned numbers authority) has reserved the range `169.254.0.0` to `169.254.255.255` for the allocation of automatic private IP addresses (APIPA). Addresses from this range are guaranteed to cause no conflicts with any routable IP address.
2. Try to establish a connection to the R&S NRPM3N with both the default hostname and the hostname extended with `.local`, for example:
   `nrpm3n-101441`
   `nrpm3n-101441.local`

### 6.3.5.1 Using hostnames

In a LAN that uses a domain name system (DNS) server, each connected computer or instrument can be accessed via an unambiguous hostname instead of an IP address. The DNS server translates the hostname to the IP address. Using the hostname is especially useful when a DHCP server is used, as a new IP address can be assigned each time the instrument is restarted.

Each sensor module is delivered with a default hostname assigned. You can change the default hostname.

#### Default hostname

The default hostname follows the syntax:

`<device name>-<serial number>`, where:

- `<device name>` is the short name of your sensor module.
  For example, the `<device name>` of R&S NRPM3N is `nrpm3n`.
- `<serial number>` is the individual serial number of the sensor module. The serial number is printed on the name plate at the rear side of the sensor module. It is part of the device ID printed above the barcode:


**Example:**

Serial number of the R&S NRPM3N: 102333

Default hostname: NRPM3N-102333

#### Hostname in zero configuration networks, including peer-to-peer networks

The sensor module supports zero configuration networking, used in networks without DHCP server, such as peer-to-peer networks. Thus, you can connect the sensor module to a network without setting up services such as dynamic host configuration protocol (DHCP) and domain name system (DNS), or configuring the network settings manually.

For establishing a connection to the sensor module, try the default hostname and the hostname extended with `.local` as shown in the example below. All communication for resolving names in the top-level-domain (TLD) `.local` are defined to be executed using dedicated local services and ports if no other DNS (domain name server) is available.

**Example:**

Default hostname: `nrpm3n-102333`

Extended hostname: `nrpm3n-102333.local`

#### 6.3.5.2 Assigning the IP address

Depending on the network capabilities, the TCP/IP address information for the R&S NRPM3N LAN sensor module can be obtained in different ways:

- If the network supports dynamic TCP/IP configuration using the dynamic host configuration protocol (DHCP), the address information can be assigned automatically.
- If the network does not support DHCP, the R&S NRPM3N LAN sensor module tries to obtain the IP address via the zeroconf (APIA) protocol. If this attempt does not succeed or if the instrument is set to use alternate TCP/IP configuration, the IP address must be set manually.

**Use hostnames to identify the sensor module**

In networks using a DHCP server, it is recommended that you address the sensor module by its unambiguous hostnames, see Section 6.3.5.1, "Using hostnames", on page 46.

A *hostname* is a unique identifier of the sensor module that remains permanent as long as it is not explicitly changed. Hence, you can address a sensor module by the same identification, irrespectively if a network or a point-to-point connection is used.

## 6.4 Starting the measurement

**To start the measurement**

To start an R&S NRPM OTA power measurement, it is assumed that all components of the test setup are connected.

An easy way for configuring the measurement and displaying results is given by the R&S Power Viewer software:

► Start the R&S Power Viewer application, see "To start the application" on page 49.

The R&S Power Viewer identifies sensor modules that are connected to USB automatically. If you are working with an R&S NRPM3N network sensor module, define the corresponding network connection in the R&S Power Viewer "Sensor' > VISA Connection" dialog, before you start a measurement.

# 7 Performing measurements

## 7.1 Sensor module readings

The antenna modules R&S NRPM-A90 and R&S NRPM-A90D have an integrated diode detector each that converts the RF signal and transmits it directly to the sensor module.

You can measure the power of the incident electromagnetic wave towards the antenna module in various quantities:

- Equivalent isotropically received power $P_{ISO} = P_i$ in W or dBm (default):
  Equivalent detected power of an isotropic antenna with an ideal power detector at the phase center location of the antenna module assuming radiation only from boresight direction.
- Power at the internal RF detector in W or dBm: The measurement result without including antenna gain and frequency-dependent calibration factors.
  $P_{Det}=(G_{RF,i}/k_{att,A,i}(f))\cdot P_{ISO}$
- Power density S in W/m$^2$, calculated as:
  $S=(4\pi/\lambda^2)\cdot P_{ISO}$
- Electric field strength $E_{eff}$ in V/m, calculated as:
  $E_{eff}=\sqrt{(S\cdot Z_0)}$ with: $Z_0$=376.73 Ω.
- Magnetic field strength $H_{eff}$ in A/m, calculated as:
  $H_{eff}=\sqrt{(S/Z_0)}$ with: $Z_0$=376.73 Ω.

► To convert the data, use the remote command:
`CALCulate:MATH[:EXPRession]` on page 127

## 7.2 Measurement applications

For power measurement with the R&S NRPM3(N), you can either use the PC application R&S Power Viewer, the WebGUI (Web User Interface) or an application that supports direct remote control of the sensor module.

The following sections introduce the power measurement with the R&S Power Viewer and the WebGUI (web user interface). Section Section 11, "Programming examples", on page 159 describes the corresponding programming examples for working in remote control mode. See the R&S Power Viewer manual for more information on how to use the various functions of the application.

The descriptions refer to the applications running on an MS Windows system. It is assumed that the measurement is set up, and the required software and drivers are installed on the PC.

## 7.2.1 Using R&S Power Viewer

This section shows how to start the application and access the settings relevant for OTA measurements.

For handling and using the tool in detail, see the "R&S Power Viewer Software Manual" that comes with the installation. See also Section 4.6.3, "R&S Power Viewer", on page 22.

The R&S Power Viewer supports measuring the received signals of up to 12 antenna modules, and enables you to perform simultaneous OTA measurements of four sensor module, each transmitting the readings of up to three antenna modules.

The R&S Power Viewer provides the following measurement modes for OTA measurements:

- "OTA Single"
  Evaluates the continuous average power of up to 3 antenna module signals measured by an R&S NRPM3(N).
  Controls one R&S NRPM3(N) sensor module, i.e. you can measure the continuous average power of up to 3 antenna module signals.
- "OTA Multi Sensor"
  Supports the measurements of up to four sensor modules, i.e. you can measure the continuous average power of up to 12 antenna module signals.
- "OTA Trace Measurement"
  Controls one sensor module, i.e. you can measure the power of up to 3 antenna module signals in trace mode.

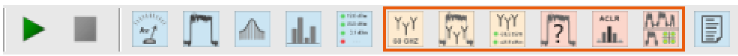
Outlined are:

- To start the application.
- To configure an OTA single sensor ContAV measurement, for using the R&S NRPM3(N) with up to three antenna modules.
- To configure an OTA multi-sensor ContAV measurement, for using up to four sensor modules with up to three antenna modules each.
- To configure an OTA single sensor trace power measurement, for using the sensor module with up to three antenna modules.

### To start the application

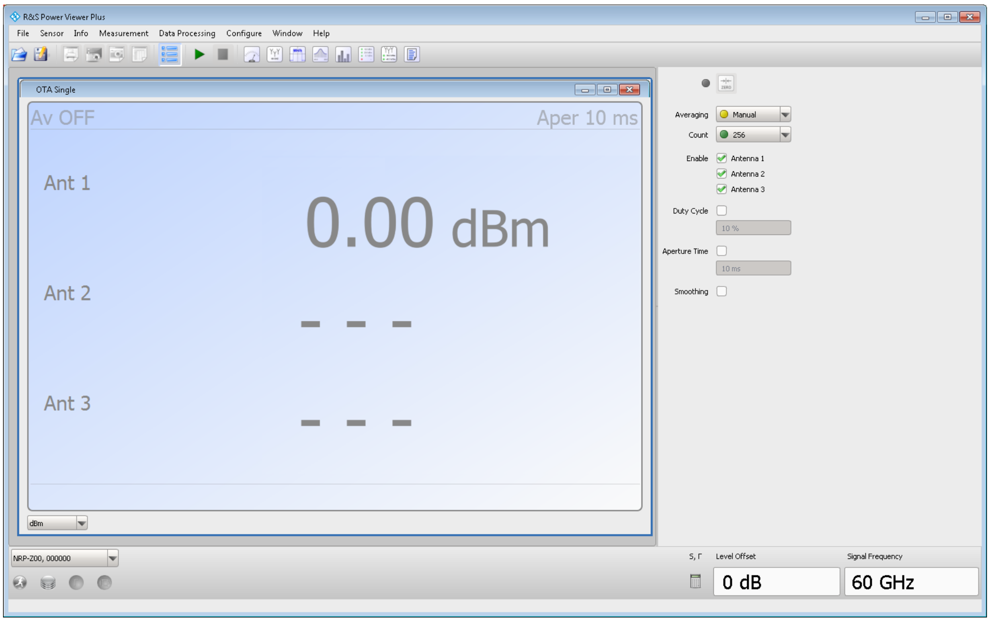
► In the MS Windows start menu, select "Start" > "R&S Power Viewer" > "Power Viewer".

  The application starts. It provides buttons for OTA measurements in the toolbar.

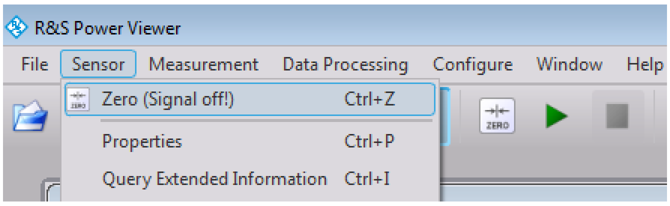


### To configure an OTA single sensor ContAV measurement

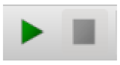
1. In the toolbar, select the "OTA Single" button to open the panel for the OTA measurements with one R&S NRPM3(N).




2. In the lower border toolbar, select the sensor module.
3. Execute zeroing:
   **Note:** Turn off all measurement power signals before zeroing. An active measurement during zeroing causes an error.
   a) Turn off the measurement signal.
   b) Select "Sensor > Zero (Signal off)".




4. In the panel on the right, select the antenna modules for the measurement.
5. If necessary, set the parameters to configure the continuous average power measurement.
6. Set the frequency.
7. Start the measurement.

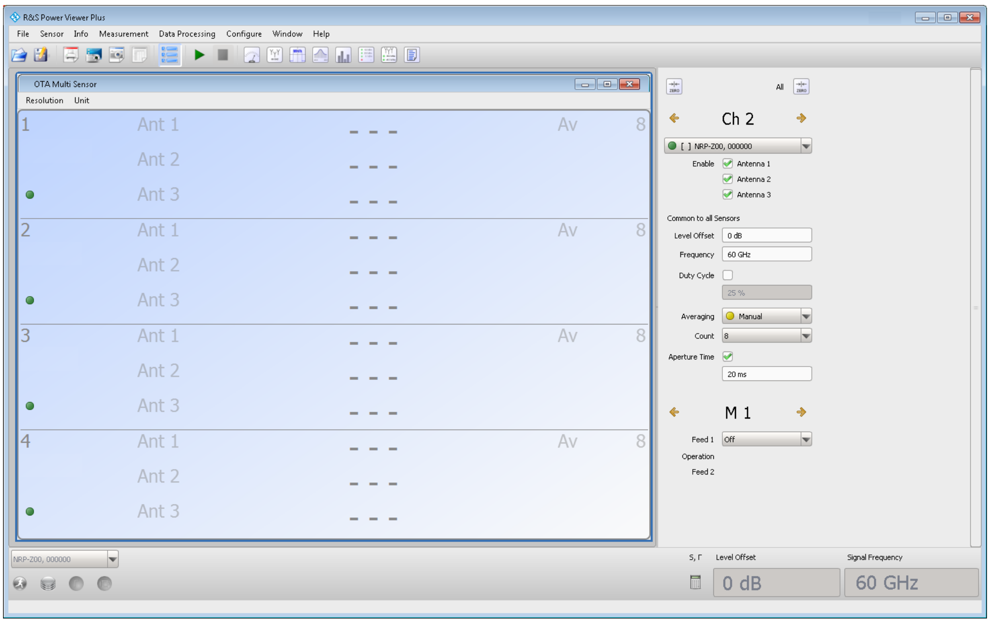



The measurement result window displays measured power in the sensor module channels.

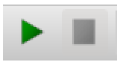
**To configure an OTA multi-sensor ContAV measurement**

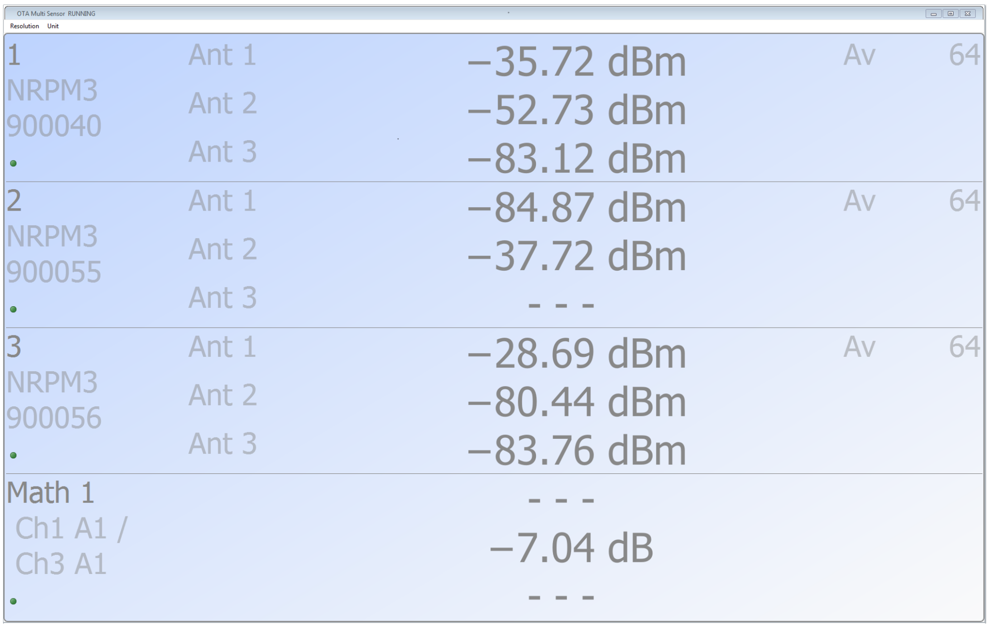
1. 

   In the toolbar, select the "OTA Multi Sensor" button to open the panel for the OTA measurements with several sensor modules.



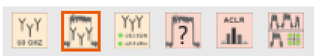
2. In the lower border toolbar, select the sensor module.
3. In the panel on the right, select the channel.
4. Enable the antenna modules of the selected channel.
5. If necessary, set the parameters provided for the measurement mode.
6. Repeat step 3 to step 5 for each channel.
7. Repeat step 2 to step 6 for each connected sensor module.
8. Set the frequency.
9. Start the measurement.



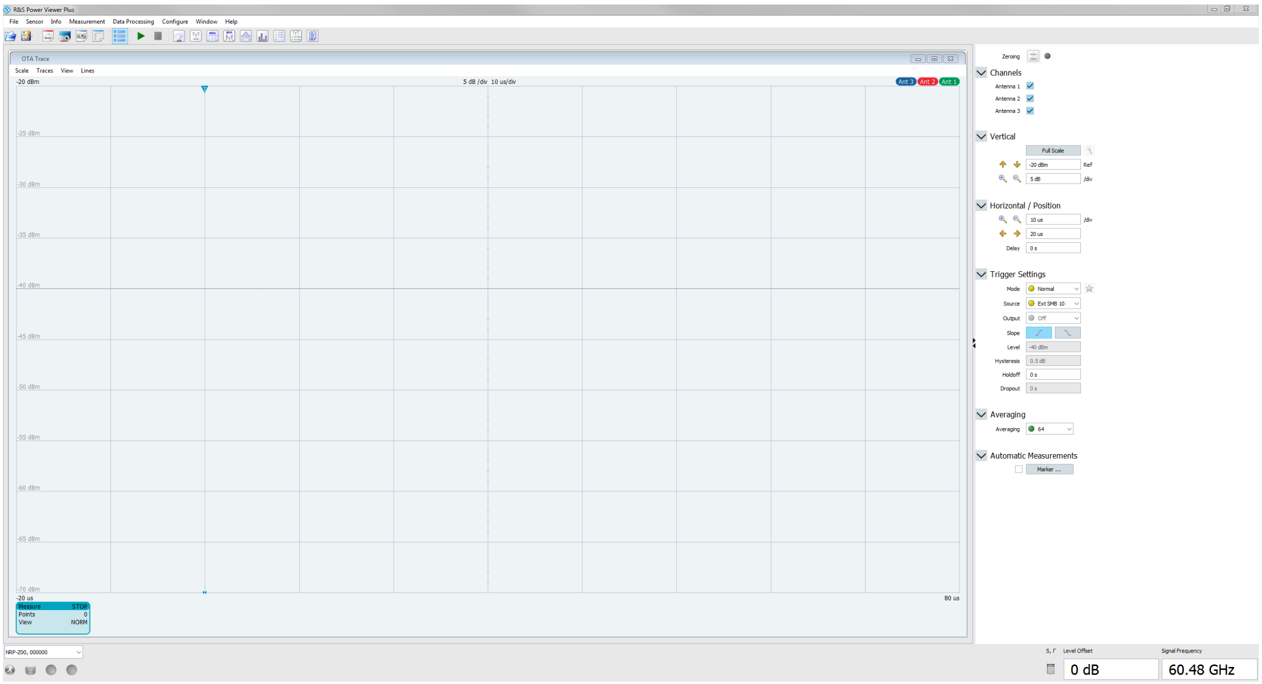



The measurement results window displays the results of the multi-channel measurement.

**To configure an OTA single sensor trace power measurement**

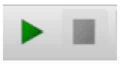
1. 

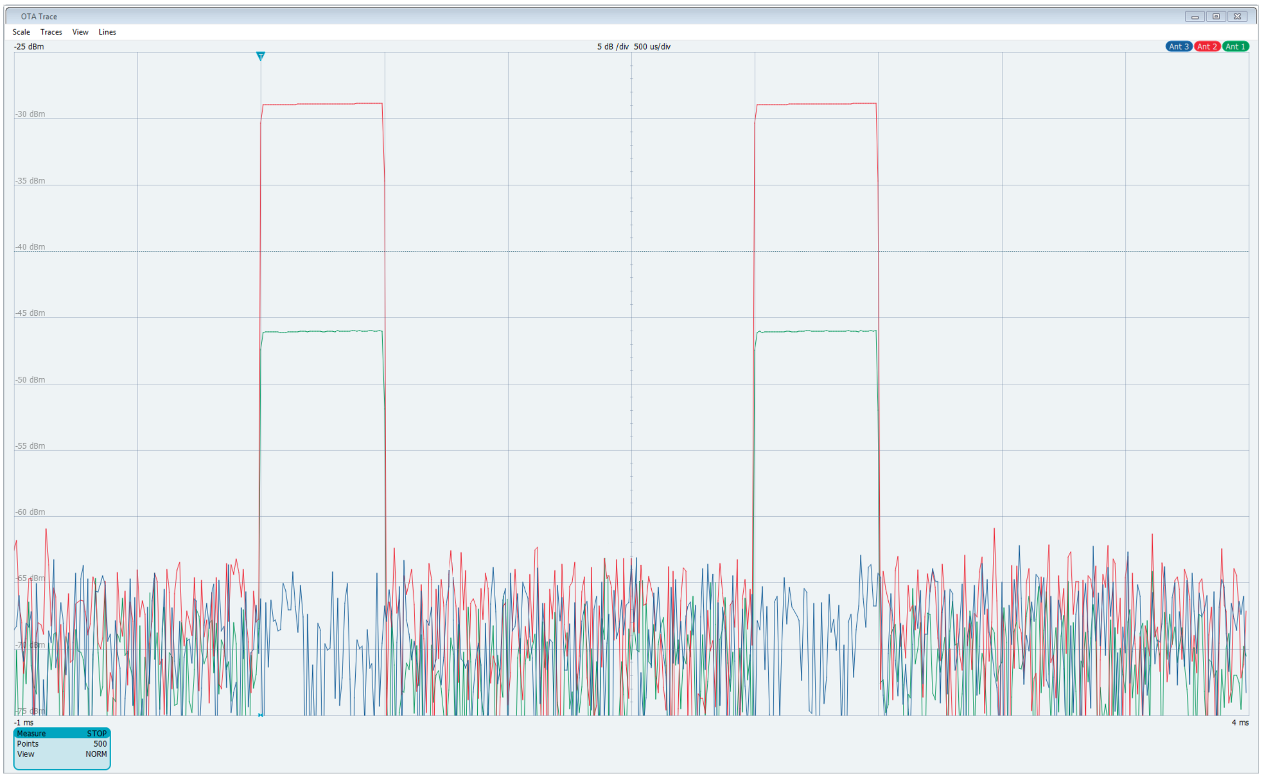
In the toolbar, select the button to open the panel for trace measurements.



The R&S Power Viewer displays the trace measurement results windows, and the setting parameters in the panel on the right.

2. In the lower border toolbar, select the sensor module.
3. In the panel on the right, select the antenna modules for the measurement.
4. If necessary, adjust the scaling of the measurement results window.
5. If necessary, set the trigger and averaging parameters provided for "Trace" measurements.
6. Set the frequency.
7. Start the measurement.






The results window displays the trace measurement results of the three antenna modules.

### 7.2.2 Using the web user interface

Requires a sensor module with networking capabilities, an R&S NRPM3N.

The web user interface is an alternative way to operate an R&S NRPM3N LAN sensor module. With the integrated, browser-based graphical user interface of the R&S NRPM3N sensor module, you can configure the most common settings and measure in the provided measurement modes.

On the sensor module, there is no installation required. With the integrated web user interface, you can easily configure the most common settings of the sensor module and measure in the provided measurement modes.

The following browsers are supported:

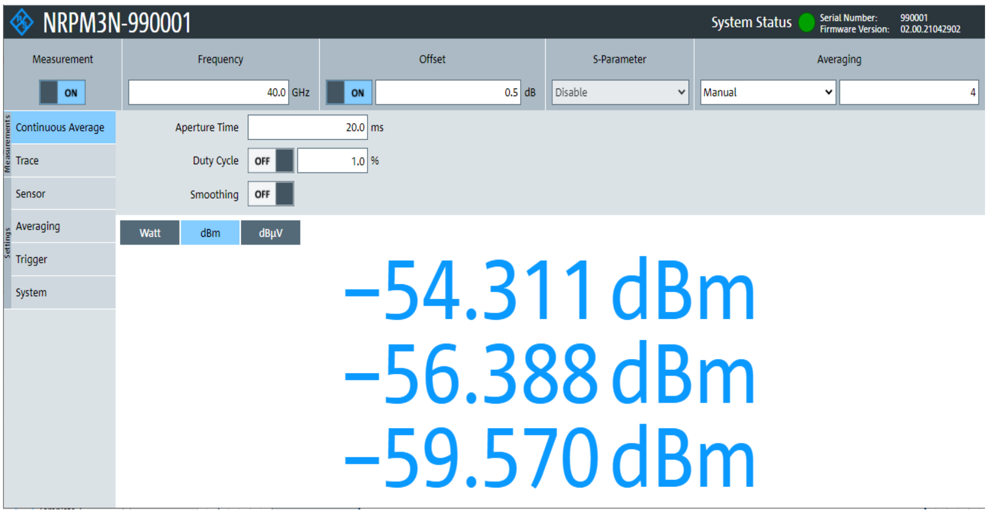
- Mozilla Firefox
- Google Chrome
- Microsoft Edge

- Safari

You can use the web user interface with all devices and operating systems, including tablets and smart phones that are connected to the same network as the sensor module.

**Starting a measurement**

1. Set up the LAN connection, as described in Section 6.3.4, "Using the LAN connection", on page 42.
2. Open a supported web browser.
3. Enter the instrument name or the IP address of the sensor module you want to connect to.
   `Example: http://nrpm3n-990001`
   For details on how to find out the IP address or hostname, refer to Section 6.3.5.2, "Assigning the IP address", on page 47 and Section 6.3.5.1, "Using hostnames", on page 46.




   The main dialog of the web user interface opens.
4. In the "Measurements" navigation pane, select "Continuous Average".
5. Enter your settings.
6. Select "Measurement > ON" to start the measurement.

The following chapters describe the functions and parameters of the web user interface in detail.

### 7.2.2.1 Main dialog of the web user interface

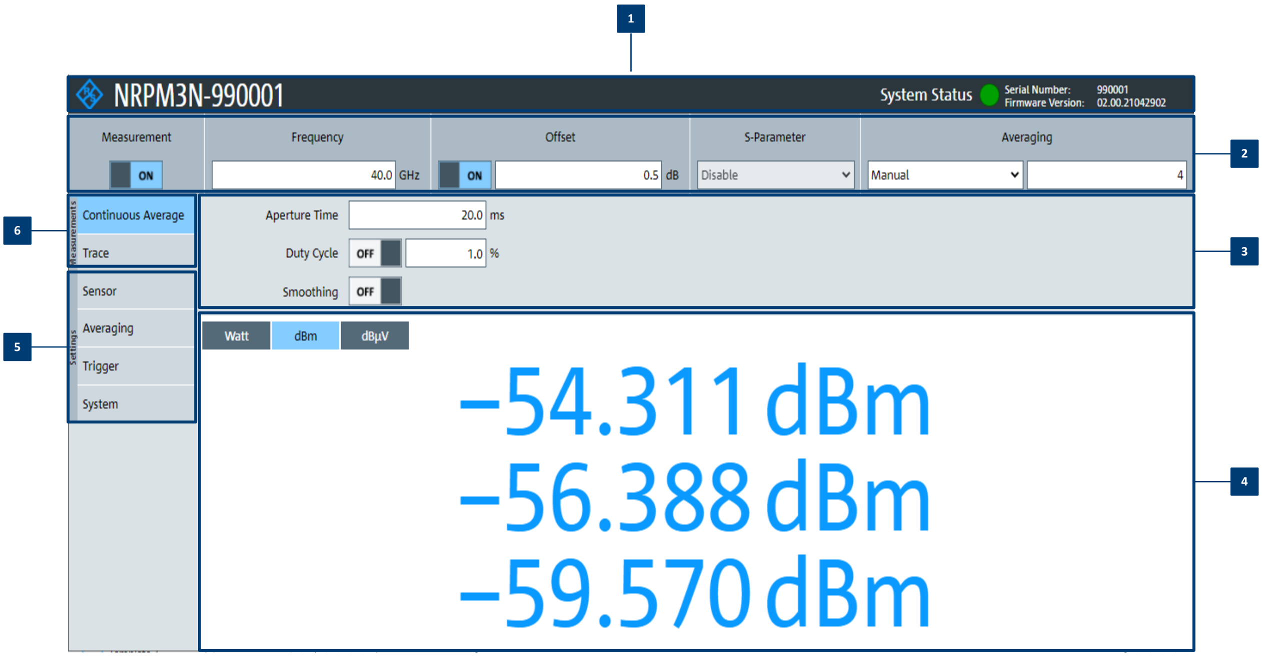



*Figure 7-1: Layout of the web user interface*

1 = Title bar
2 = Common settings, see Section 7.2.2.3, "Common settings", on page 58
3 = Parameter pane
4 = Result pane
5 = "Settings" navigation pane, see Section 7.2.2.5, "Settings", on page 61
6 = "Measurements" navigation pane, see Section 7.2.2.4, "Measurement modes", on page 59

#### Title bar

Shows the following information:

- R&S logo
  If you click the R&S logo, the Rohde & Schwarz homepage is displayed on a new browser tab.
- Sensor module name or host name
  If you click the name, the product page of the sensor module is displayed on a new browser tab.
  See Section 6.3.5.1, "Using hostnames", on page 46.
- System status
  Confirms that there is a connection between the sensor module and the remote computer and that the sensor module is recognized by the software. The presentation of this symbolic LED mirrors the physical LED of the sensor module.
  See "Status LED (2)" on page 25.

#### Parameter pane

Displays the content selected in the navigation pane.

**Result pane**

Displays the measurement result for the selected measurement mode. It can display only a value or a graph, depending on the selected measurement mode.

### 7.2.2.2 Setting the unit

You can set the unit for the different parameters by typing the corresponding letter after the entered value.

**Example:**

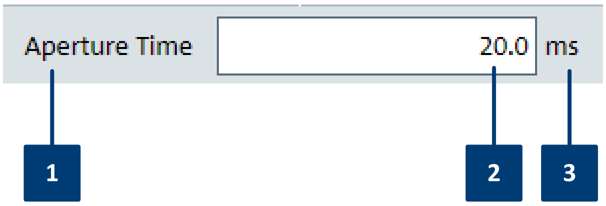



***Figure 7-2: Parameter***

1 = Parameter name
2 = Value
3 = Unit

The following abbreviations are available:

| Unit | Keyboard key |
|---|---|
| Decibel | *d* |
| Hertz | *h* |
| Second | *s* |
| Volt | *v* |
| Watt | *w* |

| Unit multiples | Keyboard key |
|---|---|
| Giga | *g* |
| Mega | *m* |
| Kilo | *k* |
| milli | *m* |
| micro | *u* |
| nano | *n* |

**Example:**
To set the unit to 1 GHz, enter *1g*.

For certain units, you can select a different representation, depending on the requirements. For example, for the representation of the "Trigger Level", you can choose Watt, dBm or dBµV. To change the unit, you must specify the desired value together with the full new unit once.

**Example:**

To change the representation of a "Trigger Level" of 100µW into dBm, enter *-10dbm* in the "Trigger Level" field. All future entries of solely numbers represent the value in dBm. If you enter *-15* in the field, the "Trigger Level" value is set to -15.00 dBm.

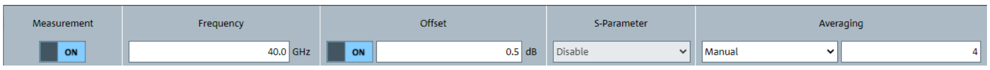
If you want to revert the value to Watt, enter *50uW*. The "Trigger Level" value is set a value of 50.00 µW, thus changing the unit for the further numeric entries.

#### 7.2.2.3 Common settings

Describes common measurement settings that are available for all measurement modes.

Access:

► In the common settings pane of the web user interface main dialog, select the corresponding parameter.




The remote commands required to define the common settings are described in:

- Section 10.9, "Starting and ending a measurement", on page 145
- Section 10.8.3, "Configuring corrections", on page 143



**System Status**

Displayed in the title bar. The status confirms that there is a connection between the sensor and the remote computer and that the sensor is recognized by the software.

The presentation of this symbolic LED mirrors the physical LED of the sensor, see "Status LED (2)" on page 25.

**Measurement**

Activates the measurement.

Remote command:

`INITiate:CONTinuous` on page 146

**Frequency**
Sets the carrier frequency of the applied signal. This value is used for frequency-response correction of the measurement result.

Remote command:
[SENSe<Sensor>:]FREQuency on page 142

**Offset**
Sets and enables a level offset.

**<State> ← Offset**
Activates the level offset.

Remote command:
[SENSe<Sensor>:]CORRection:OFFSet:STATe on page 144

**<Value> ← Offset**
Adds a fixed level offset in dB to account for external losses.

Remote command:
[SENSe<Sensor>:]CORRection:OFFSet on page 144

**S-Parameter**
**Note:** S-parameter compensation is not supported by the R&S NRPM3 sensor modules.

**Averaging**
See Section 10.8.1, "Configuring averaging", on page 140.

### 7.2.2.4 Measurement modes

Provides the parameters for the supported measurement modes.

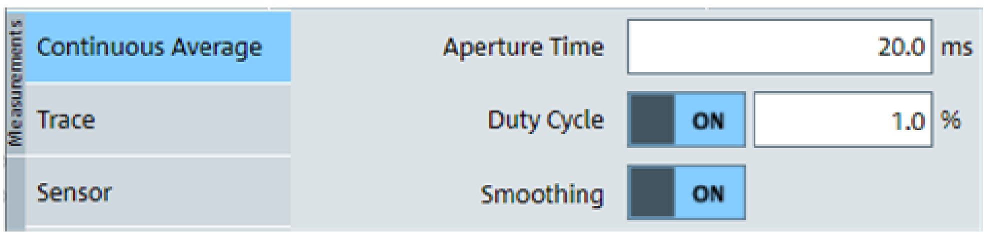


#### Continuous Average mode

Describes the parameters of the continuous average measurement.

Access:

► In the measurement navigation pane of the web user interface, select "Continuous Average".



The remote commands required to define the continuous average settings are described in Section 10.7.1, "Configuring a continuous average measurement", on page 129.



**Aperture Time**

Sets the aperture time, the width of the sampling windows.

Remote command:
[SENSe<Sensor>:][POWer:][AVG:]APERture on page 130

**Duty Cycle**

Sets the duty cycle, the percentage of one period during which the signal is active, for pulse modulated signals. If activated, the sensor calculates the signal pulse power from its value and the average power.

Remote command:
[SENSe<Sensor>:]CORRection:DCYCle:STATe on page 144
[SENSe<Sensor>:]CORRection:DCYCle on page 143

**Smoothing**

Activates the smoothing filter, a steep-cut off digital low-pass filter. The filter reduces result fluctuations caused by modulation.

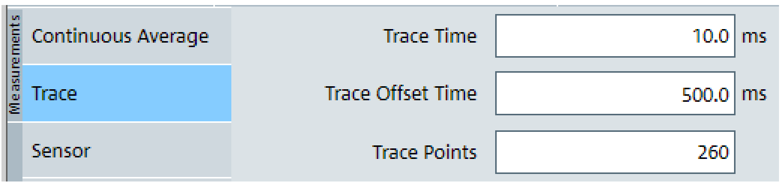
Remote command:
[SENSe<Sensor>:][POWer:][AVG:]SMOothing:STATe on page 132

### Trace mode

Provides the parameters of the trace measurement.

Access:

► In the measurement navigation pane of the web user interface main dialog, select "Trace".




The remote commands required to define the trace settings are described in Section 10.7.3, "Configuring a trace measurement", on page 133.

**Trace Time**

Sets the trace length.

Remote command:
`[SENSe<Sensor>:]TRACe:TIME` on page 139

**Trace Offset Time**

Sets the relative position of the trigger event in relation to the beginning of the trace measurement sequence. Used to specify the start of recording for the trace mode.

Remote command:
`[SENSe<Sensor>:]TRACe:OFFSet:TIME` on page 138

**Trace Points**

Sets the number of required values per trace sequence. For achieving a good optimum between the measurement speed and the resolution, you can set a value of, e.g. 200 trace points.

Remote command:
`[SENSe<Sensor>:]TRACe:POINts` on page 138

### 7.2.2.5 Settings

Describes the parameters for general configuration.

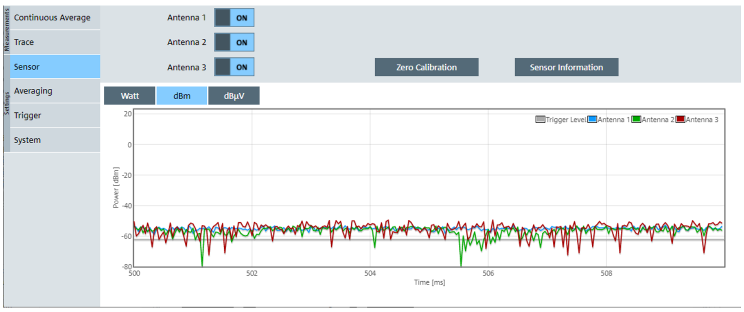


#### Sensor settings

The sensor settings window provides the parameters for optimizing the measurement results for specific measurement requirements.

Access:

► In the settings navigation pane of the web user interface, select "Sensor".




The remote commands required to define the sensor settings are described in:


● Section 10.4.2, "Handling of available antenna modules", on page 113
● Section 10.8.3, "Configuring corrections", on page 143
● Section 10.13, "Calibrating/zeroing the R&S NRPM3(N) sensor module", on page 157

- Section 10.12, "Testing the R&S NRPM OTA Power Measurement Solution", on page 156



**Antenna**

Activates an antenna module module for the measurement.

Remote command:

`[SENSe<Sensor>:]CHANnel<Channel>:PRESence?` on page 113

`[SENSe<Sensor>:]CHANnel<Channel>[:ENABle]` on page 114

**Zero Calibration**

Executes zeroing using the signal at the sensor module input, see Section 10.13, "Calibrating/zeroing the R&S NRPM3(N) sensor module", on page 157.

**Note:**

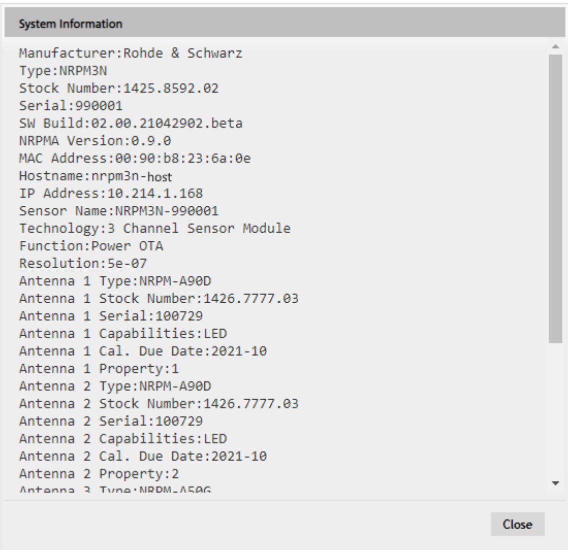
Turn off all test signals before zeroing. An active test signal during zeroing causes an error.

Remote command:

`CALibration<Channel>:ZERO:AUTO` on page 157

**Sensor Information**

Provides information on the R&S NRPM OTA power measurement system.

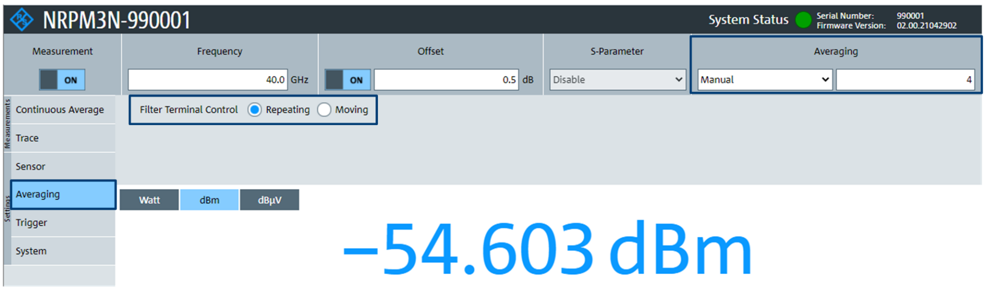



### Averaging settings

Describes the parameters for automatic averaging.

Access:

► In the settings navigation pane of the web user interface, select "Averaging".




The remote commands required to define the averaging settings are described in Section 10.8.1, "Configuring averaging", on page 140.



**Averaging Mode**

Indicates that the R&S NRPM3N works in manual averaging mode and enables you to set the average count, also considered as averaging factor.

See Section 10.8.1, "Configuring averaging", on page 140.

**<Mode> ← Averaging Mode**

Displays the averaging mode.

"manual" Operates in manual mode only.
Enter the average count under <Value>.

Remote command:
`[SENSe<Sensor>:]AVERage[:STATe]` on page 142

**<Value> ← Averaging Mode**

Sets the average count.

Remote command:
`[SENSe<Sensor>:]AVERage:COUNt` on page 140

**Filter Terminal Control**

Defines the output mode for the measurement results, denoted as termination control.

See also Section 10.5, "Controlling the measurement", on page 116.

"Repeating" Provides the measurement result only after the entire measurement has been completed.
The number of measurement cycle repetitions corresponds to the set averaging factor, and thus directly relates to the measurement duration: the higher the averaging factor, the longer the measurement time.

"Moving" Provides intermediate values to facilitate early detection of changes in the measured quantity. In the settled state, i.e. when the number of measurements specified by the averaging factor has been performed, the sensor module provides a moving average.

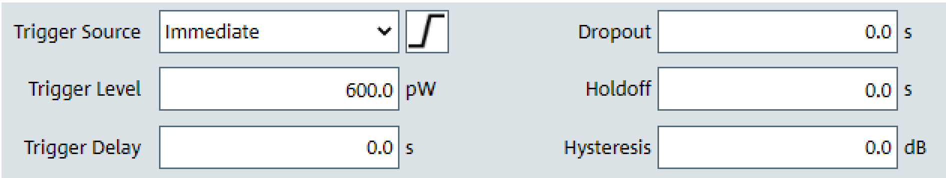
Remote command:
`[SENSe<Sensor>:]AVERage:TCONtrol` on page 141

### Trigger settings

Provides the trigger parameters. You can define the conditions that have to be fulfilled for a triggered measurement.

Access:

► In the settings navigation pane of the web user interface, select "Trigger".




The remote commands required to define the trigger settings are described in:
- Section 10.10, "Configuring the trigger", on page 146
- Section 10.5, "Controlling the measurement", on page 116



**Trigger Source**
Selects the source and slope polarity of the trigger signal.

You can use an internal or externally applied trigger signal.

**<Source> ← Trigger Source**
Selects the trigger source, see "Trigger sources" on page 117.

Remote command:
`TRIGger:SOURce` on page 151

**<Slope> ← Trigger Source**
Sets the polarity of the active slope of the trigger signal.

"Positive" Uses the rising edge of the trigger signal.

"Negative" Uses the falling edge of the trigger signal.

Remote command:
`TRIGger:SLOPe` on page 151

**Trigger Level**
Sets the trigger threshold for internal triggering derived from the test signal.

Remote command:
`TRIGger:LEVel` on page 150
`TRIGger:LEVel:UNIT` on page 150

**Trigger Delay**
Sets the delay between the trigger event and the actual start of the measurement.

Remote command:
`TRIGger:DELay` on page 148
`TRIGger:DELay:AUTO` on page 148

**Dropout**
With a positive (negative) trigger slope, the dropout time is the minimum time for which the signal must be below (above) the power level defined by Trigger Level.

Remote command:
`TRIGger:DTIMe` on page 148

**Holdoff**
Sets the hold-off time.

After a trigger event, the sensor module suppresses all trigger events that occur within this time period.

Remote command:
`TRIGger:HOLDoff` on page 149

**Hysteresis**
Sets the hysteresis in dB. A trigger event occurs, if the trigger level:
- Falls below the set value on a rising slope.
- Rises above the set value on a falling slope.

Thus, you can use this setting to eliminate the effects of noise in the signal for the edge detector of the trigger system.

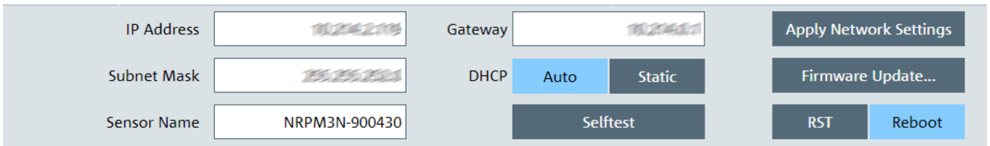
Remote command:
`TRIGger:HYSTeresis` on page 149

### 7.2.2.6 System settings

Provides the parameters of the general network environment and specific identification parameters of the sensor module in the network.

Access:

► In the settings navigation pane of the web user interface, select "System".




The remote commands required to define the system settings are described in Section 10.4.1, "Configuring the system", on page 99.



**IP Address**

Sets the IP address of the sensor module.

Remote command:
`SYSTem:COMMunicate:NETWork:IPADdress` on page 104

**Subnet Mask**

Sets the subnet mask.

The subnet mask consists of four number blocks separated by dots. Every block contains 3 digits at a maximum.

Remote command:
`SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK` on page 105

**Sensor Name**

Assigns a name for the sensor module. The web user interface indicates the name in the title bar, see Figure 7-1.

If you do not specify a sensor name, the hostname is used as default, see `SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname` on page 103.

Remote command:
`SYSTem[:SENSor]:NAME` on page 109

**Gateway**

Sets the address of the default gateway that means the router that is used to forward traffic to destinations beyond the local network. This router is on the same network as the instrument.

Remote command:
`SYSTem:COMMunicate:NETWork:IPADdress:GATeway` on page 105

**DHCP**
Selects the mode for assigning the IP address.

"Auto" Assigns the IP address automatically, provided the network supports DHCP (dynamic host configuration protocol).

"Static" Enables you to assign the IP address manually.

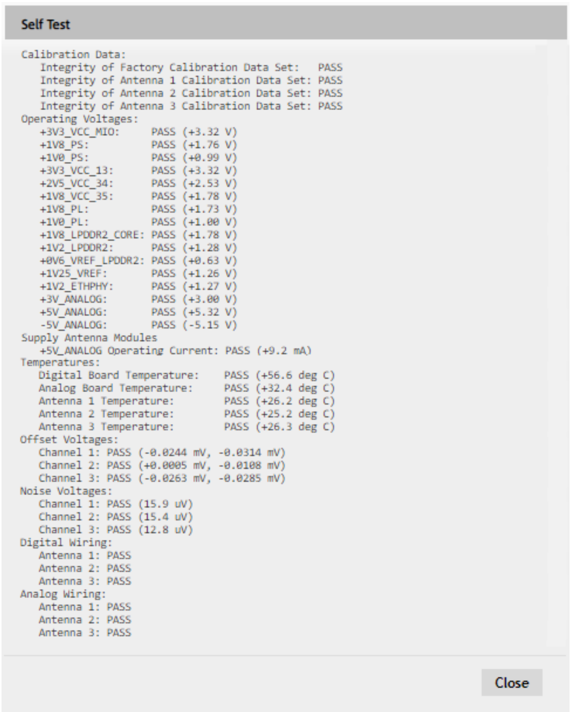
Remote command:
`SYSTem:COMMunicate:NETWork:IPADdress:MODE` on page 105

**Selftest**
Initiates a selftest of the sensor.

**Note:**
Do not apply a signal to the sensor module while the selftest is running.

Executing the self-test with an active signal assigned, can erroneously result in error messages at the test steps *Offset Voltages* and/or *Noise Voltages*.

When completed, the web user interface displays a report with the test results.




Remote command:
`TEST:SENSor?` on page 156

**Apply Network Settings**
After you have completed the required network settings changes, confirm the modification with "Apply Network Settings".

**Update**

Opens a dialog to start the firmware update. For further information, see Section 8.2.2, "Using the web user interface", on page 72.

Alternatively, you can update the firmware with the firmware update program, see Section 8.2.1, "Using the firmware update program", on page 70, or remotely, see Section 8.2.4, "Using remote control", on page 73.

Remote command:
`SYSTem:FWUPdate` on page 101
`SYSTem:FWUPdate:STATus?` on page 102

**Sensor Preset**

Click the "RST" button to perform a preset. The R&S NRPM stops the running measurement, changes to the continuous average measurement and awaits the start of a new measurement.

Use the preset functionality to set the R&S NRPM to a defined state. The preset allows you to change parameter values from a defined starting point.

Remote command:
`*RST`

**Reboot Sensor**

Reboots the R&S NRPM. When the reboot is completed, press [F5] to reload the web browser page.

Remote command:
`SYSTem:REBoot` on page 100

# 8 Firmware update



## 8.1 Downloading the firmware update file

Firmware update files of R&S sensor modules generally have an RSU extension, RSU meaning Rohde & Schwarz update.

**To download the RSU file**

1. Download the most recent firmware version from the Rohde & Schwarz homepage on the internet. The latest firmware update files are available at:
   www.rohde-schwarz.com/firmware/NRPM
2. Save the RSU file on the computer.
3. If the RSU file is packed in a `*.zip` archive, extract it.

## 8.2 Updating the firmware

Do not interrupt the firmware update because an interruption can lead to missing or faulty firmware. Take special care not to disconnect the power supply while the update is in progress. Interrupting the power supply during the firmware update most likely leads to an unusable sensor module that needs to be sent in for maintenance.

A firmware update can take up to 5 minutes.

If you want to downgrade to an older version, you cannot use an RSU file downloaded from the Rohde & Schwarz homepage on the internet. Contact our costumer support to receive a special downgrade file for your sensor. See Section 12.6, "Contacting customer support", on page 178.

You have several options to update the firmware installed on an R&S NRPM3(N) sensor module.

### 8.2.1 Using the firmware update program

The firmware update program is part of the R&S NRP-Toolkit, see Section 4.6.2, "R&S NRP-Toolkit", on page 20.

#### Checking the prerequisites

To make sure that you have fulfilled all prerequisites:

1. **Note:** You can update the firmware with firmware update, when the sensor module is recognized as a VISA device.
   Make sure that a recent VISA software is installed on the computer.
2. Make sure that the R&S NRP-Toolkit is installed on the computer.

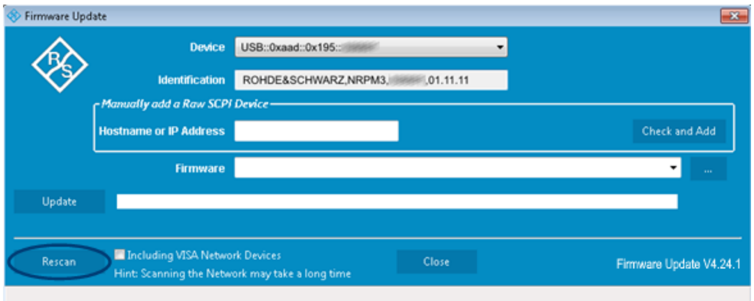
#### Firmware update

It is assumed, that you have checked and fulfilled the prerequisites.

To update the firmware:

1. Connect the sensor module to the computer as described in Section 6.3.2, "Connecting to the controller PC", on page 39.
2. Start the firmware update program:
   "Start" menu > "NRP-Toolkit" > "Firmware Update".

   The program starts scanning for Rohde & Schwarz sensor modules connected over USB.
   When the scan is completed, it lists all recognized sensor modules under "Device".
3. If the sensor module you want to update is not listed, perform one of the following actions:
   a) Make sure the sensor module is physically connected.
   b) Select "Rescan". This function starts a new search for sensor modules.

   c) Check whether all necessary drivers are installed on the computer.
   For example, if the VISA library is not installed on the computer, no VISA sensor modules is accessible.
   See also "Troubleshooting" on page 71.
4. Select the sensor module you want to update in the "Device" list.

   **Note:** The "Hostname or IP Address" field is not used during this procedure. Therefore, leave it empty.

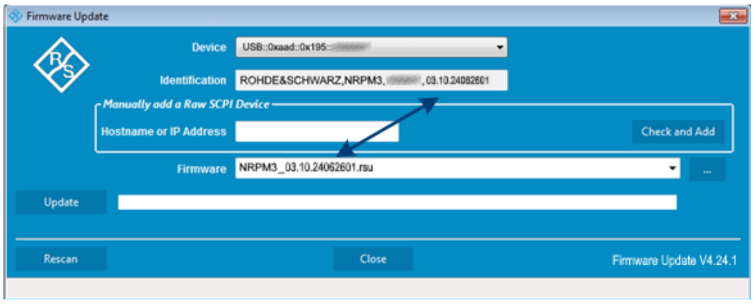
5. In the "Firmware" field, enter the full path and filename of the update file, or press the browse button next to the field and select it.

   If you have updated the firmware on your sensor module before, path and filename are displayed. New firmware for the Rohde & Schwarz sensor modules generally has an `*.rsu` (Rohde & Schwarz update) extension.

6. Select "Update".

   During the update process, the program displays a progress bar and information on the current state. The update sequence can take a couple of minutes.

7. Check if the update was successful. The firmware version in the "Identification" field must match the version you selected in the "Firmware" field.




### Troubleshooting

#### R&S NRPM3N LAN sensor module not detected

You do not find the sensor module in the list of sensor modules provided by firmware update.

The driver assigned to the sensor module is the legacy driver.

► Install a recent VISA software.

#### Exclamation mark denotes a discrepancy

The sensor module is highlighted by a yellow exclamation mark in the Windows device manager.

Windows tries in vain to find a USB driver for the sensor module.

► Install a recent VISA software.

#### Firmware update failed

If the update was not successful:

1. Check whether all necessary drivers are installed on the computer.
   For example, if the VISA library is not installed, no VISA power sensor is accessible.

2. Check if the VISA software is up-to-date.

3. Install the corresponding driver or VISA software.

For further information, see:

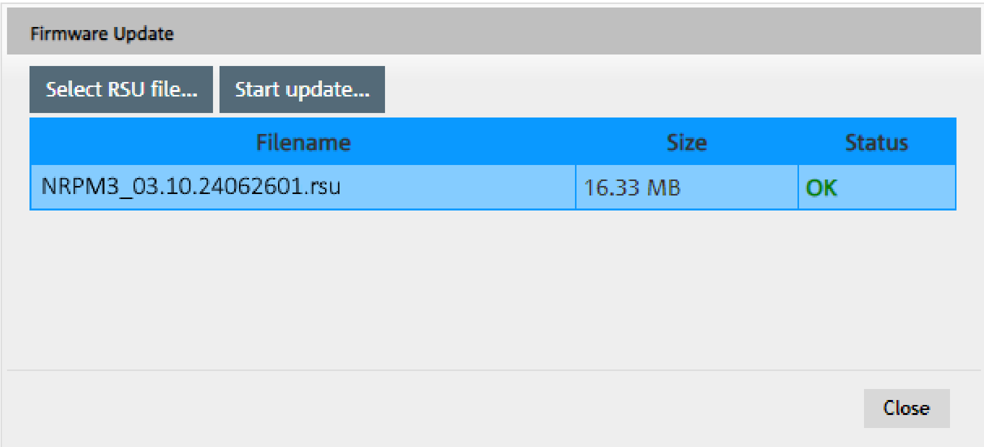
- "Checking the prerequisites" on page 70
- Section 12.3, "Problems during a firmware update", on page 174

## 8.2.2 Using the web user interface

Requires a sensor module with networking capabilities, an R&S NRPM3N.

1. Connect the sensor module to the computer as described in Section 6.3.4, "Using the LAN connection", on page 42.
2. Open the web user interface as described in Section 7.2.2, "Using the web user interface", on page 54.
3. In the navigation pane, select "System".
4. Select "Firmware Update".
5. In the "Firmware Update" dialog, select "Select RSU file".
6. In the file browser, select the `*.rsu` file for upload.

   The dialog displays the selected file with file size and status.

7. Select "Start update".

   During the update process, the program displays a progress bar and information on the current state. The update sequence can take a couple of minutes. When completed, the dialog closes automatically.

### 8.2.3 Using FTP

Requires a sensor module with networking capabilities, an R&S NRPM3N.

You can transfer the update file to the sensor module using FTP (file transfer protocol).

1. Connect the sensor module to the computer on which you have saved the RSU file. See Section 6.3.4, "Using the LAN connection", on page 42.
2. On the computer, start the Windows Explorer.
3. In the address field, enter one of the following:
   - *ftp://<IP address of the sensor module>*, for example *ftp://11.111.1.11*
   - *ftp://<host name of the sensor module>*

   A logon dialog opens and requests authentication.
4. Enter the user identification and password.
   See Section 10.4.1.4, "Password management", on page 102.
5. Open the `update` directory.
6. Copy the new RSU file into the directory.

   When the copying process is completed, the firmware update starts automatically.

The files in the `update` directory are deleted automatically at every reboot.

### 8.2.4 Using remote control

If you want to integrate a firmware update function in an application, use `SYSTem:FWUPdate` on page 101.

**Example:**

You want to update your R&S NRPM3N with the `NRPM3_03.10.24062601.rsu` file. This file has a size of 10242884 bytes.

To send the file to the sensor module for updating the firmware, your application has to assemble a memory block containing:

`SYST:FWUP <block_data>`

The `<block_data>` are definite length-arbitrary block data.

See `SYSTem:FWUPdate` on page 101.

The size of the file is 10242884. This number has 8 digits. Thus, the `<block_data>` consist of the following:

- #
- 8
  How many digits follow to specify the file size.

- 10242884
  The number that specifies the file size.
- <file_contents>
  Contents of the RSU file, byte-by-byte
- 0x0a
  Delimiter

In this example, you write exactly 10242905 bytes to the sensor module, for example by using a 'viWrite()' function.

The 10242905 bytes result from the values of the list above:

9 + 1 + 1 + 1 + 8 + 10242884 + 1

In a (pseudo) string notation, the memory block looks like this:

```
SYST:FWUP #810242884<file_contents>0x0a,
```

# 9 Network and remote operation

In addition to controlling an R&S NRPM3(N) sensor module on a PC application, you can operate and control it with an application that supports direct remote control from a remote PC.

The following sections contain product-related information on remote control of the R&S NRPM3(N) sensor module. The information applies to all applications and operating modes.

For general information on remote control of Rohde & Schwarz products using SCPI commands, refer to Remote control via SCPI.

## 9.1 Remote control interfaces and protocols

Remote control of sensor modules enables you to integrate them into custom automatic test equipment (ATE) systems. For remote control communication between the R&S NRPM and the controlling host, you can use various interfaces and protocols to establish the connection.

Depending on the sensor module model, the sensor modules support the following interfaces:

- R&S NRPM3 sensor modules support USB access.
- R&S NRPM3N sensor modules support Ethernet or USB access.

Table 9-1 lists the protocols you can use for the corresponding interfaces.

*Table 9-1: Remote control interfaces and protocols*

| Interface | Supported by | Protocols, VISA*) address string and library |
|---|---|---|
| USB | R&S NRPM3<br>R&S NRPM3N | **USBTMC**<br>USB::<vendor ID>::<product ID>::<serial number>[::INSTR]<br>VISA |
| Ethernet | R&S NRPM3N | • **VXI-11**<br>TCPIP::host address[::LAN device name][::INSTR]<br>VISA<br>• **HiSLIP** high-speed LAN instrument protocol (IVI-6.1)<br>TCPIP::host address::hislip0[::INSTR]<br>VISA<br>• **Socket communication** (LAN Ethernet)<br>TCPIP::host address[::LAN device name]::<port>::SOCKET |
| (*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control over LAN (when using VXI-11 or HiSLIP protocol) and USBTMC interfaces. | | |

## 9.1.1 USB interface

For remote control over the USB, the computer and the sensor modules must be connected over the USB interface. A USB connection requires that you have installed the VISA library. VISA detects and configures a sensor module automatically when the USB connection is established. Apart from the USBTMC driver (which comes with the installation of the R&S NRP-Toolkit), you do not have to install a separate driver.

USBTMC is a protocol that is built on top of USB for communication with USB devices. It defines class code information of the sensor module, that identifies its functionality to load the respective device driver. Usually, the USBTMC functions are implemented in VISA libraries provided by various vendors.

A VISA library covers basic I/O functions (open, close, read, write, etc.). It also supports service requests, triggers and other operations over USB and LAN interfaces that were previously implemented only for GPIB devices.

### USB resource string

The resource string represents an addressing scheme that is used to establish a communication session with the sensor module. It is based on the sensor module address and some instrument- and vendor-specific information.

The syntax of the used USB resource string is:

```
USB::<vendor ID>::<product ID>::<serial number>[::INSTR]
```

Where:

- <vendor ID> is the vendor ID for Rohde & Schwarz (0x0AAD).
- <product ID> is the product ID for the Rohde & Schwarz sensor module.
- <serial number> is the individual serial number at the rear of the sensor module.

*Table 9-2: R&S NRPM3(N) USB product IDs*

| Sensor module | USB product ID |
|---|---|
| R&S NRPM3 | 0x0195 |
| R&S NRPM3N | 0x0196 |

**Example:**

```
USB::0x0AAD::0x0196::100001
```

0x0AAD is the vendor ID for the Rohde & Schwarz sensor module.

0x0196 is the product ID for the particular model (here R&S NRPM3N sensor module).

100001 is the serial number of the sensor module.

## 9.1.2 Ethernet interface

The Ethernet interface of the R&S NRPM3N LAN sensor modules allows you to integrate them in a local area network (LAN).

For remote control via a network, the computer and the sensor module must be connected via the Ethernet interface to a common network with TCP/IP network protocol. The TCP/IP network protocol and the associated network services are preconfigured on the sensor module. Software for device control and the VISA program library must be installed on the computer.

### 9.1.2.1 VISA resource string

The VISA resource string is required to establish a communication session between the controller and the R&S NRPM3N in a LAN. The resource string is a unique identifier, composed of the specific IP address of the sensor module and some network and VISA-specific keywords.

TCPIP::<IP address or hostname>[::<LAN device name>][::INSTR]

- *TCPIP* designates the network protocol used
- *<IP address or hostname>* is the IP address or host name of the device
- *[::<LAN device name>]* defines the protocol and the instance number of a subinstrument:
- *[::INSTR]* indicates the sensor module resource class (optional)

The IP address or hostname is used by the programs to identify and control the sensor module. While the hostname is determined by settings in the sensor module, the IP address is assigned by a DHCP server when the sensor module requests one. Alternatively the IP address is determined with a procedure called Zeroconf.

You can also assign a *LAN device name* which defines the protocol characteristics of the connection. See the description of the VISA resource string below for the corresponding interface protocols. The string of the *LAN device name* is emphasized in italics.

**HiSLIP**

TCPIP::<IP address or hostname>*::hislip0*[::INSTR]

- *hislip0* is the HiSLIP device name, designates that the interface protocol HiSLIP is used (mandatory)

*hislip0* is composed of [::HiSLIP device name[,HiSLIP port]] and must be assigned.

For details of the HiSLIP protocol, refer to Section 9.1.2.3, "HiSLIP protocol", on page 78.

**VXI-11**

TCPIP::<IP address or hostname>*[::inst0]*[::INSTR]

- *inst0* is the LAN device name, indicating that the VXI-11 protocol is used (optional)

*inst0* currently selects the VXI-11 protocol by default and can be omitted.

For details of the VXI-11 protocol, refer to Section 9.1.2.2, "VXI-11 protocol", on page 78 .

**Socket communication**

TCPIP::<IP address or hostname>*::port::SOCKET*

- *port* determines the used port number
- *SOCKET* indicates the raw network socket resource class

Socket communication requires the specification of the port (commonly referred to as port number) and of "SOCKET" to complete the VISA resource string with the associated protocol used.

The default port for socket communication is port 5025.

For details of the socket communication, refer to Section 9.1.2.4, "Socket communication", on page 79.

**Example:**

A sensor module has the IP address *10.111.11.20*; the valid resource string using VXI-11 protocol is:

TCPIP::10.111.11.20::INSTR

The DNS host name is *nrpm3-100001*; the valid resource string is:

TCPIP::nrpm3-100001::hislip0 (HiSLIP)

TCPIP::nrpm3-100001::inst0 (VXI-11)

A raw socket connection can be established using:

TCPIP::10.111.11.20::5025::SOCKET

TCPIP::nrpm3-100001::5025::SOCKET

### 9.1.2.2 VXI-11 protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

### 9.1.2.3 HiSLIP protocol

The HiSLIP (high-speed LAN instrument protocol) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - the first for fast data transfer, the second one for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls

- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

The HiSLIP data is sent to the device using the "fire and forget" method with immediate return. Opposed to VXI-11, where each operation is blocked until a VXI-11 device handshake returns. Thus, a successful return of a VISA operation such as `viWrite()` does not guarantee that the sensor module has finished (or even started) executing the requested command. It just indicates that the command has been delivered to the TCP/IP buffers.

For more information see also the application note at:

http://www.rohde-schwarz.com/appnote/1MA208.

#### 9.1.2.4 Socket communication

An alternative way for remote control of the software is to establish a simple TCP/IP connection to the device using the standard network drivers of your operating system. The so-called "socket" on Linux, "winsock" on Windows. The socket communication, also referred to as "raw Ethernet communication", does not necessarily require a VISA installation on the remote controller side.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or hostname of the sensor module and the number of the port configured for remote control. The sensor modules use port number 5025 for this purpose.

## 9.2 Status reporting system

The status reporting system stores all information on the current operating state of the sensor module, and on errors which have occurred. This information is stored in the status registers and in the error queue. You can query both with the commands of the `STATus` subsystem.

### 9.2.1 Hierarchy of the status registers

Fig.9-1 shows the hierarchical structure of information in the status registers.

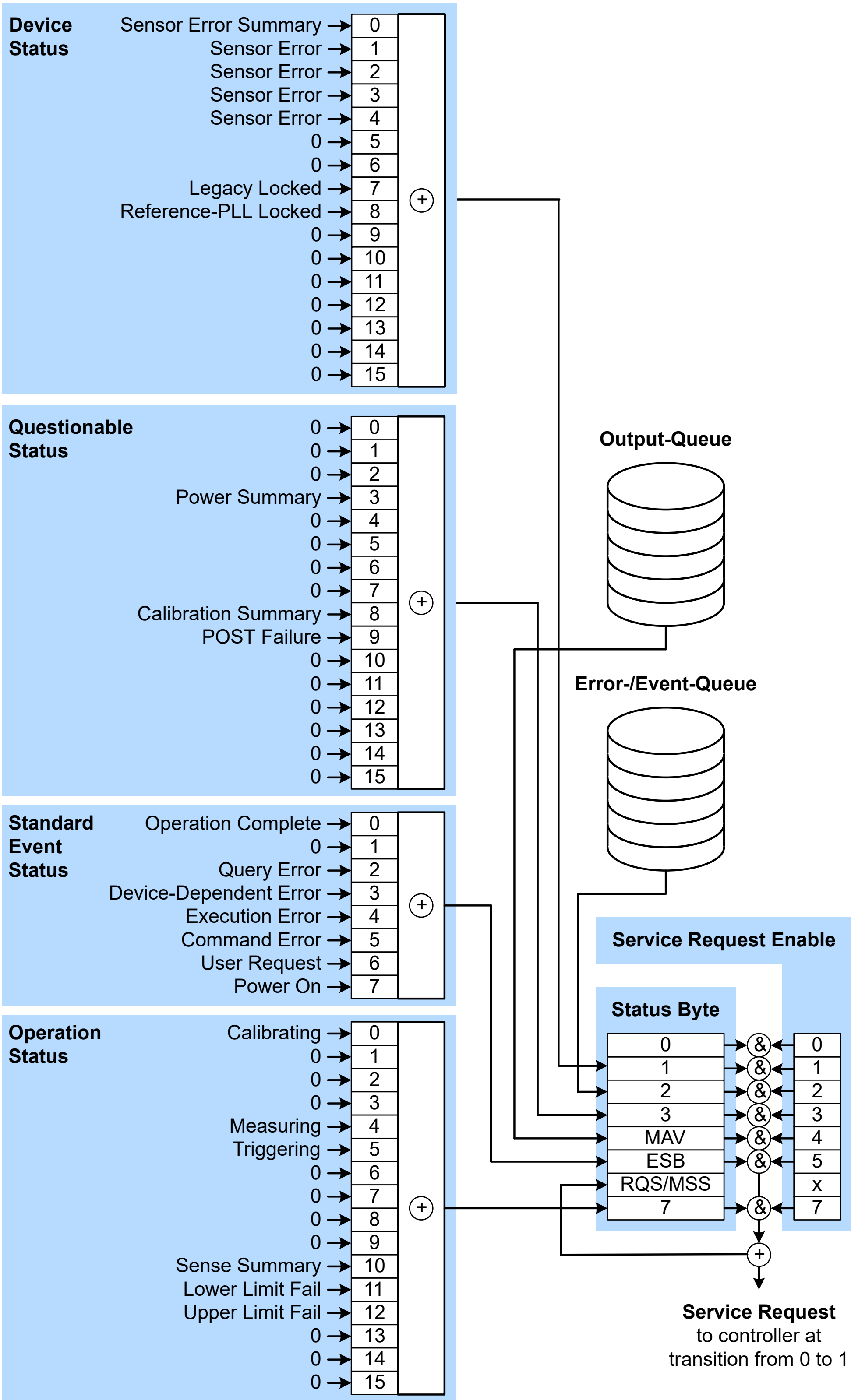



*Figure 9-1: Graphical overview of the status registers hierarchy*

The highest level is formed by the status byte register (STB) and the associated service request enable (SRE) register.

The STB receives its information from the standard event status register (ESR) and the associated Standard Event Status Enable (ESE) Register, as well as from the SCPI-defined operation status register, and the questionable status register, which contain detailed information on the device, and from the device status register.

### 9.2.2 Structure of an SCPI status register

Each SCPI register consists of five 16-bit registers which have different functions (see Figure 9-2). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is the same for all five registers. Bit 15 (the most-significant bit) is set to zero in all registers. This prevents problems some controllers have with the processing of unsigned integers.

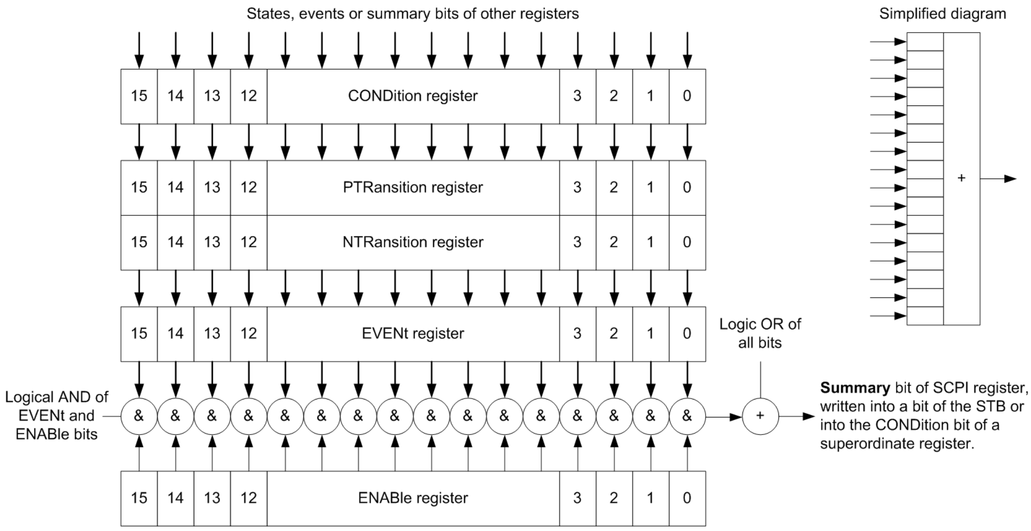



*Figure 9-2: Standard SCPI status register*

#### CONDition status register part

The five parts of an SCPI register have different properties and functions:

The CONDition part is written into directly by the hardware or the sum bit of the next lower register. Its contents reflect the current instrument status. This register part can only be read, but not written into or cleared. Its contents are not affected by reading.

#### PTRansition / NTRansition status register part

The two transition register parts define which state transition of the CONDition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

The *Positive TRansition* part acts as a transition filter. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.

- PTR bit =1: the EVENt bit is set.
- PTR bit =0: the EVENt bit is not set.

This part can be written into and read as required. Its contents are not affected by reading.

The *Negative TRansition* part also acts as a transition filter. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.

- NTR bit =1: the EVENt bit is set.
- NTR bit =0: the EVENt bit is not set.

This part can be written into and read as required. Its contents are not affected by reading.

**EVENt status register part**

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument.

This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.

**ENABle status register part**

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (see below). Each bit of the EVENt part is "ANDed" with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an "OR" function (symbol '+').

ENABle bit = 0: the associated EVENt bit does not contribute to the sum bit.

ENABle bit = 1: if the associated EVENt bit is "1", the sum bit is set to "1" as well.

This part can be written into and read by the user as required. Its contents are not affected by reading.

**Sum bit**

The sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.

The instrument automatically generates the sum bit for each register. Thus an event can lead to a service request throughout all levels of the hierarchy.

## 9.2.3 Status byte (STB) and service request enable register (SRE)

The STB is already defined in IEEE 488.2. It gives a rough overview of the sensor module status, collecting information from the lower-level registers. It is comparable with the CONDition register of an SCPI defined register and is at the highest level of the SCPI hierarchy. Its special feature is that bit 6 acts as the summary bit of all other bits of the Status Byte Register.

The status byte is read by the query *STB? or a serial poll. The SRE is associated with the STB. The function of the SRE corresponds to that of the ENABle register of the SCPI registers. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated on the IEC/IEEE bus, which triggers an interrupt in the controller configured for this purpose, and can be further processed by the controller.

The SRE can be set by the command `*SRE` and read by the query `*SRE?`.

*Table 9-3: Meaning of bits used in the status byte*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **Device status register summary bit**<br>Depending on the configuration of the sensor modules status register, this bit is set when a sensor module is connected or disconnected or when an error has occurred in a sensor module.<br>See Section 9.2.5, "Device status register", on page 84. |
| 2 | **Error queue not empty**<br>The bit is set if the error queue has an entry. If this bit is enabled by the SRE, each entry of the error queue generates a service request. An error can thus be recognized and specified in detail by querying the error queue. The query yields a conclusive error message. This procedure is recommended since it considerably reduces the problems of IEC/IEEE-bus control. |
| 3 | **Questionable status register summary bit**<br>This bit is set if an `EVENt` bit is set in the `QUEStionable` status register and the associated `ENABLe` bit is set to 1. A set bit denotes a questionable device status which can be specified in greater detail by querying the QUEStionable Status Register.<br>See Section 9.2.6, "Questionable status register", on page 85. |
| 4 | **MAV bit** (Message available)<br>This bit is set if a readable message is in the output queue. This bit may be used to automate reading of data from the sensor module into the controller. |
| 5 | **ESB: Standard event status register summary bit**<br>This bit is set if one of the bits in the standard event status register is set and enabled in the event status enable register. Setting this bit denotes a serious error which can be specified in greater detail by querying the standard event status register.<br>See Section 9.2.7, "Standard event status and enable register (ESR, ESE)", on page 87. |

| Bit No. | Meaning |
|---|---|
| 6 | **MSS: Master status summary bit**<br>This bit is set if the sensor module triggers a service request. This is the case if one of the other bits of this register is set together with its enable bit in the service request enable register (SRE). |
| 7 | **Operation status register summary bit**<br>This bit is set if an `EVENt` bit is set in the operation status register and the associated `ENABLe` bit is set to 1. A set bit denotes that an action is being performed by the sensor module. Information on the type of action can be obtained by querying the operation status register.<br>See Section 9.2.8, "Operation status register", on page 88. |

## 9.2.4 IST flag and parallel poll enable register (PPE)

Similar to the SRQ, the IST flag combines the complete status information in a single bit. It can be queried by a parallel poll or by the `*IST?` command.

The Parallel Poll Enable Register (PPE) determines which bits of the STB affect the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE; bit 6 is also used - in contrast to the SRE. The IST flag is obtained by `ORing` all results together.

The PPE can be set by the `*PRE` command and read by the`*PRE?` query.

## 9.2.5 Device status register

Contains information on the state of the static errors.

Querying the register:

- `STATus:DEVice:CONDition?`
- `STATus:DEVice[:EVENt]?`

Querying the static errors:

- `SYSTem:SERRor?`

***Table 9-4: Meaning of bits used in the device status register***

| Bit No. | Meaning |
|---|---|
| **0** | **Sum of SERR bits**<br>The sum/combination of SERR bits 1 to 4. |
| **1** | **SERR measurement not possible** |
| **2** | **SERR erroneous results**<br>Static error exists; the measurement result is possibly incorrect. |
| **3** | **SERR warning**<br>A static error exists therefore the Status LED of the sensor module is blinking slowly in red. |

| Bit No. | Meaning |
|---|---|
| 4 | **SERR critical**<br>A critical static error exists therefore the Status LED of the sensor module is blinking fast in red. |
| 5 to 6 | Not used |
| 8 | **Reference PLL locked state**<br>This bit signals whether the PLL for the clock reference is synchronized. The bit is useful when selecting an external clock source.<br>The following states are possible:<br>• Internal clock ( `[SENSe<Sensor>:]ROSCillator:SOURce INTernal INT`):<br>– `1` (always)<br>• External clock ( `[SENSe<Sensor>:]ROSCillator:SOURce EXTernal`):<br>– `1` if the sensor module was able to synchronize with external clock<br>– `0` if the sensor module could not synchronize with external clock |
| 9 to 15 | Not used |

## 9.2.6 Questionable status register

Contains information on questionable sensor module states. Such states may occur when the sensor module is not operated in compliance with its specifications.

Querying the register:

- `STATus:QUEStionable:CONDition?`
- `STATus:QUEStionable[:EVENt]?`

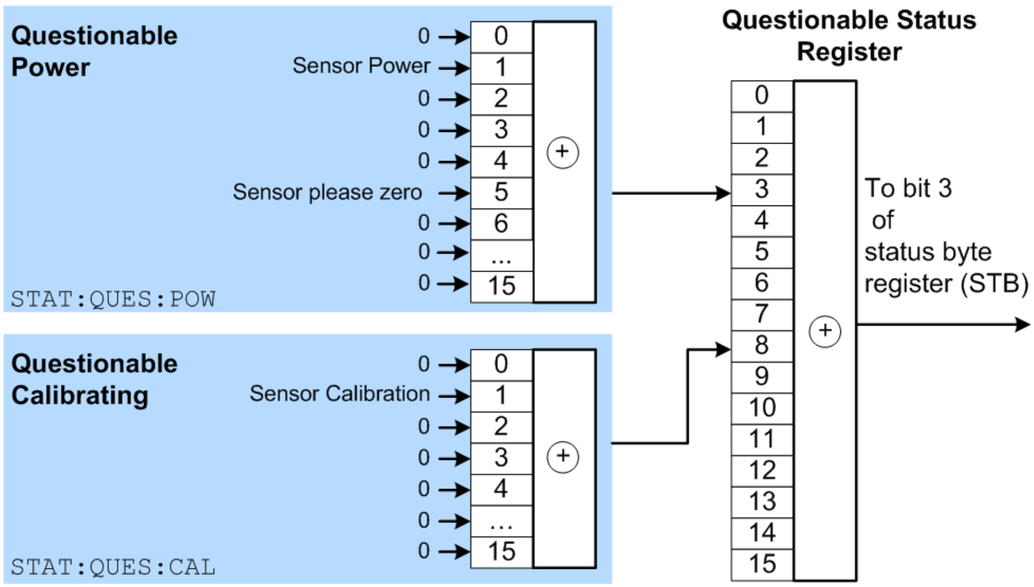


*Table 9-5: Meaning of bits used in the questionable status register*

| Bit No. | Meaning |
|---|---|
| **0 to 2** | Not used |
| **3** | **Questionable power status register summary bit**<br>Corresponds to the summary bit of the questionable power status register.<br>See Section 9.2.6.1, "Questionable power status register", on page 86. |
| **4 to 7** | Not used |
| **8** | **Questionable calibration status register summary bit**<br>Corresponds to the summary bit of the questionable calibration status register.<br>See Section 9.2.6.2, "Questionable calibration status register", on page 86. |
| **9** | **POST failure**<br>The built-in test of the R&S NRPM carried out automatically upon power-up has generated an error. |
| **10 to 15** | Not used |

### 9.2.6.1 Questionable power status register

The `CONDition` register contains information whether the measured power values are questionable.

Querying the register:

- `STATus:QUEStionable:POWer:CONDition?`
- `STATus:QUEStionable:POWer[:SUMMary][:EVENt]?`

*Table 9-6: Meaning of bits used in the questionable power status register*

| Bit No. | Meaning |
|---|---|
| **0** | Not used |
| **1** | **sensor module power**<br>The measurement data of the sensor module is corrupt. |
| **2 to 4** | Not used |
| **5** | **sensor module please zero**<br>The zero correction for the sensor module is no longer correct and should be repeated. |
| **6 to 15** | Not used |

### 9.2.6.2 Questionable calibration status register

The `EVENt` register and the `CONDition` register contain information whether the zero offset of a sensor module is still valid.

Querying the register:

- `STATus:QUEStionable:CALibration:CONDition?`
- `STATus:QUEStionable:CALibration[:SUMMary][:EVENt]?`

*Table 9-7: Meaning of bits used in the questionable calibration status register*

| Bit No. | Meaning |
|---|---|
| **0** | Not used |
| **1** | **sensor module calibration**<br>Zeroing of the sensor module was not successful. |
| **2 to 15** | Not used |

## 9.2.7 Standard event status and enable register (ESR, ESE)

The `ESR` is already defined in the IEEE 488.2 standard. It is comparable to the `EVENt` register of an SCPI register. The standard event status register can be read out by the query `*ESR`.

The `ESE` forms the associated `ENABle` register. It can be set and read out with the command/query `*ESE`.

*Table 9-8: Meaning of bits used in the standard event status register*

| Bit No. | Meaning |
|---|---|
| **0** | **Operation complete**<br>When the `*OPC` command is received, this bit is set if all previous commands have been executed. |
| **1** | Not used |
| **2** | **Query error**<br>This bit is set in either of the two following cases: the controller wants to read data from the sensor module but has not sent a query, or it sends new commands to the sensor module before it retrieves existing requested data. A frequent cause is a faulty query which cannot be executed. |
| **3** | **Device-dependent error**<br>This bit is set if a sensor module dependent error occurs. An error message with a number between -300 and -399 or a positive error number denoting the error in greater detail is entered in the error queue. |
| **4** | **Execution error**<br>This bit is set if the syntax of a received command is correct but the command cannot be executed due to various marginal conditions. An error message with a number between -200 and -300 denoting the error in greater detail is entered in the error queue. |
| **5** | **Command error**<br>This bit is set if an undefined command or a command with incorrect syntax is received. An error message with a number between -100 and -200 denoting the error in greater detail is entered in the error queue. |
| **6** | **User request**<br>This bit is set when the sensor module is switched over to manual control. |
| **7** | **Power on**<br>This bit is set when the sensor module is switched on. |

### 9.2.8 Operation status register

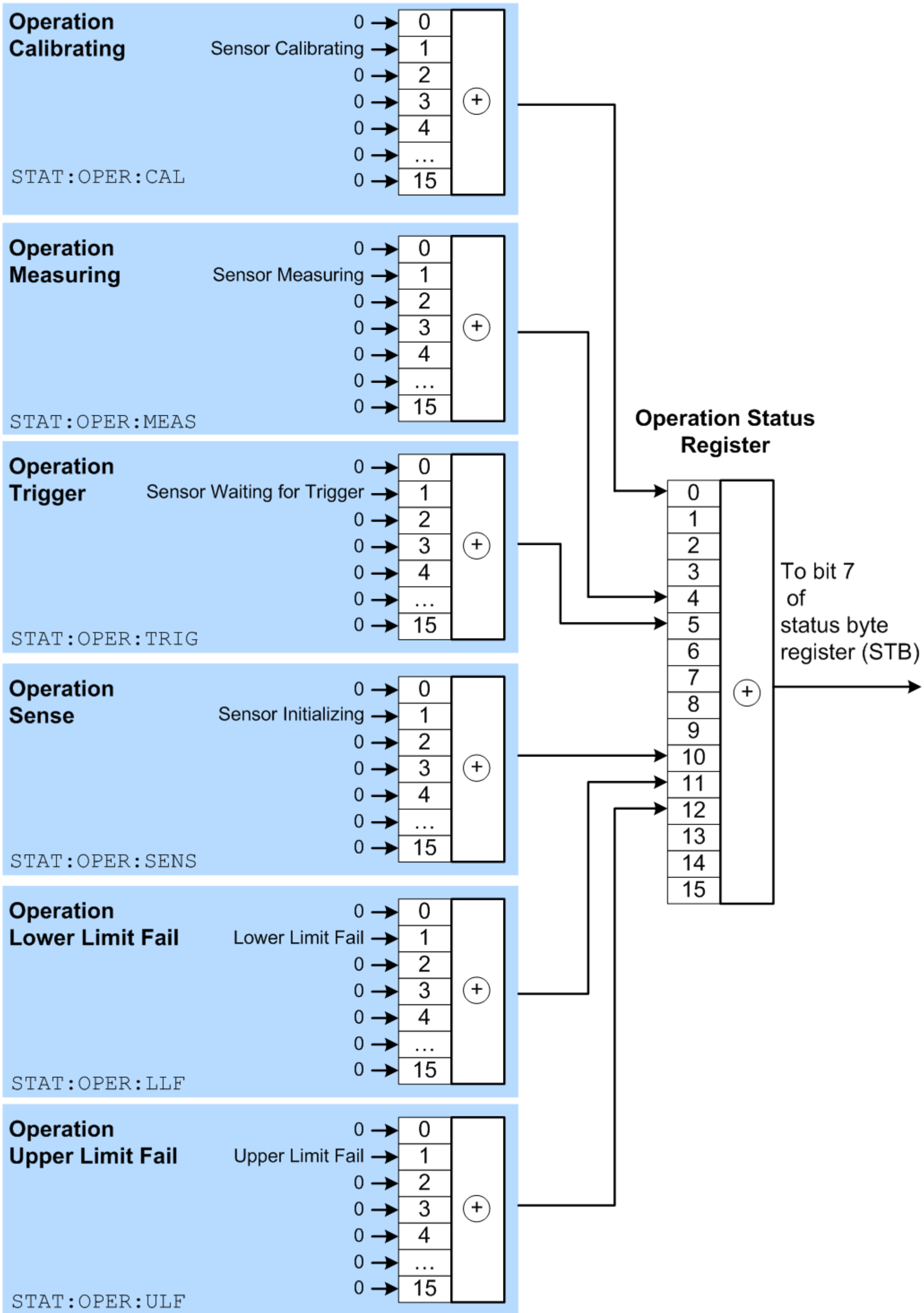
The `CONDition` register contains information on the operations currently being performed by the sensor module, while the EVENt register contains information on the operations performed by the since the last readout of the register.

Querying the register:

- `STATus:OPERation:CONDition?`
- `STATus:OPERation[:EVENt]?`

*Table 9-9: Meaning of bits used in the operation status register*

| Bit No. | Meaning |
|---|---|
| **0** | **Calibrating status register summary bit**<br>This bit is set if the sensor module is being calibrated.<br>See Section 9.2.8.1, "Operation calibrating status register", on page 89. |
| **1 to 3** | Not used |
| **4** | **Measuring status register summary bit**<br>This bit is set if the sensor module is performing a measurement.<br>See Section 9.2.8.2, "Operation measuring status register", on page 90. |
| **5** | **Trigger status register summary bit**<br>This bit is set if the sensor module is in the waiting for trigger state, i.e. waiting for a trigger event.<br>See Section 9.2.8.3, "Operation trigger status register", on page 90. |
| **6** | Not used |
| **7 to 9** | Not used |
| **10** | **Sense status register summary bit**<br>This bit is set if a sensor module is initialized.<br>See Section 9.2.8.4, "Operation sense status register", on page 91. |
| **11** | **Lower limit fail status register**<br>This bit is set if a displayed value has dropped below a lower limit value.<br>See Section 9.2.8.5, "Operation lower limit fail status register", on page 91. |
| **12** | **Upper limit fail status register**<br>This bit is set if a displayed value has exceeded an upper limit value.<br>See Section 9.2.8.6, "Operation upper limit fail status register", on page 92. |
| **13 to 14** | Not used |
| **15** | Bit 15 will never be used. |




### 9.2.8.1 Operation calibrating status register

The CONDition register contains information about whether a sensor module is currently being calibrated and, depending on the configuration of the transition register.

The EVENt register indicates whether a calibration was started or completed since the last readout of this register.

Querying the register:

- STATus:OPERation:CALibrating:CONDition?
- STATus:OPERation:CALibrating[:SUMMary][:EVENt]?

*Table 9-10: Meaning of bits used in the operation calibrating status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **sensor module calibrating**<br>The sensor module is being calibrated |
| 5 to 15 | Not used |

### 9.2.8.2 Operation measuring status register

The CONDition register contains information about whether a measurement is being performed by a sensor module and, depending on the configuration of the transition register. The EVENt register indicates whether a measurement was started or completed since the last readout of this register.

Querying the register:

- STATus:OPERation:MEASuring:CONDition?
- STATus:OPERation:MEASuring[:SUMMary][:EVENt]?

*Table 9-11: Meaning of bits used in the operation measuring status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **sensor module measuring**<br>The sensor module is performing a measurement. |
| 5 to 15 | Not used |

### 9.2.8.3 Operation trigger status register

The CONDition register contains information about whether a sensor module is currently in the waiting for trigger state, i.e. expecting a trigger event and, depending on the configuration of the transition register. TheEVENt register indicates whether the waiting for trigger state was entered or quit by a sensor module since the last readout of the register.

Querying the register:

- STATus:OPERation:TRIGger:CONDition?
- STATus:OPERation:TRIGger[:SUMMary][:EVENt]?

*Table 9-12: Meaning of bits used in the operation trigger status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **sensor module waiting for trigger**<br>The sensor module is in the waiting for trigger state and is waiting for a trigger event. When the trigger event occurs, the sensor module changes into the measuring state. |
| 5 to 15 | Not used |

### 9.2.8.4 Operation sense status register

The `CONDition` register contains information about whether a sensor module is currently being initialized and, depending on the configuration of the transition register. The `EVENt` register indicates whether a sensor module initialization was started or completed since the last readout of this register.

This status is assumed by a sensor module if one of the following conditions is met:

- The supply voltage is switched on (power up)
- The sensor module was just connected
- A reset was performed using:
  - `*RST`
  - `SYSTem:PRESet`

Querying the register:

- `STATus:OPERation:SENSe:CONDition?`
- `STATus:OPERation:SENSe[:SUMMary][:EVENt]?`

*Table 9-13: Meaning of bits used in the operation sense status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **sensor module initializing**<br>The sensor module is being initialized. |
| 5 to 15 | Not used |

### 9.2.8.5 Operation lower limit fail status register

The `CONDition` register contains information about whether a displayed value is currently below a configured lower limit. The `EVENt` register indicates whether a measured value dropped below a limit value since the last readout of the Operation Lower Limit Fail Status Register. Details of the behavior are defined by the transition register.

Querying the register:

- `STATus:OPERation:LLFail:CONDition?`
- `STATus:OPERation:LLFail[:SUMMary][:EVENt]?`

*Table 9-14: Meaning of bits used in the operation lower limit fail status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **Lower limit fail**<br>The measured value drops below the lower limit value. |
| 5 to 15 | Not used |

### 9.2.8.6 Operation upper limit fail status register

The `CONDition` register contains information about whether a displayed value is currently above a configured upper limit. The `EVENt` register indicates whether a limit value was exceeded since the last readout of the Operation Upper Limit Fail Status Register.

Querying the register:

- `STATus:OPERation:ULFail:CONDition?`
- `STATus:OPERation:ULFail[:SUMMary][:EVENt]?`

*Table 9-15: Meaning of bits used in the operation lower limit fail status register*

| Bit No. | Meaning |
|---|---|
| 0 | Not used |
| 1 | **Upper limit fail**<br>The measured value exceeds the upper limit value. |
| 5 to 15 | Not used |

# 10 Remote control commands

In the following sections, all commands implemented in the sensor are listed according to the command system and then described in detail. Mostly, the notation used complies with SCPI specifications.

## 10.1 Conventions used in SCPI command descriptions

The following conventions are used in the remote command descriptions:

- *Command usage*
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- *Parameter usage*
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as "Setting parameters".
  Parameters required only to refine a query are indicated as "Query parameters".
  Parameters that are only returned as the result of a query are indicated as "Return values".
- *Conformity*
  Commands that are taken from the SCPI standard are indicated as "SCPI confirmed". All commands used by the R&S NRPM follow the SCPI syntax rules.
- *Asynchronous commands*
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an "Asynchronous command".
- *Reset values (*RST)*
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as "*RST" values, if available.
- *Default unit*
  The default unit is used for numeric values if no other unit is provided with the parameter.

### Units

Units and prefixes, as defined by the international system of units (SI), are allowed and recognized. If you need decimal multiples and submultiples of a unit, you can use SCPI prefixes. Because SCPI uses only capital letters, it cannot distinguish between upper and lower case characters. Therefore, if SI prefixes use the same letter in upper and lower case, SCPI defines the meaning. An example is milli (m) and mega (M). In SCPI, M means milli for all units except Hz and Ohm - `MHZ` means mega Hz, $10^6$ Hz.

*Table 10-1: SCPI prefixes*

| Factor | SI name | SI symbol | SCPI prefix |
|---|---|---|---|
| $10^{3}$ | kilo | k | K |
| $10^{6}$ | mega | M | MA; also allowed are MOHM and MHZ |
| $10^{9}$ | giga | G | G |
| $10^{12}$ | tera | T | T |
| $10^{-3}$ | milli | m | M<br>Exception: Hz and Ohm |
| $10^{-6}$ | micro | µ | U |
| $10^{-9}$ | nano | n | N |
| $10^{-12}$ | pico | p | P |

## 10.2 Notations

For a detailed description of SCPI notations, see Remote control via SCPI.

**Numeric suffixes <n>**

If a command can be applied to multiple instances of an object, e.g. specific sensor modules, the required instances can be specified by a suffix added to the command. Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <I>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

**Optional keywords [ ]**

Some command systems permit certain keywords to be inserted into the header or omitted. These keywords are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

Therefore, not only is there a short and a long form for the commands (distinguished here by uppercase and lowercase letters) but also a short form which is created by omitting optional keywords.

**Example:**

Command `[SENSe<Sensor>:][POWer:][AVG:]SMOothing:STATe 1` can be written as:

`SENSe1:POWer:AVG:SMOothing:STATe 1`

`SENS:POW:AVG:SMO:STAT 1`

`SENSe:POWer:SMOothing:STATe 1`

`SENSe:SMOothing:STATe 1`

`SMOothing:STATe 1`

`SMO:STAT 1`

### Parameters

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (,).

**Example:**

Definition: `[SENSe<Sensor>:]AVERage:COUNt:AUTO:NSRatio <nsr>`

Command: `AVER:COUN:AUTO:NSR 0.01`

### Special characters | and { }

| | |
|---|---|
| \| | A vertical bar in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.<br>**Example**:<br>Definition: `INITiate:CONTinuous ON \| OFF`<br>Command `INITiate:CONTinuous ON` starts the measurements<br>Command `INITiate:CONTinuous OFF` stops the measurements |
| **{ }** | Parameters in braces may be included in the command once, several times or not at all. |

## 10.3 Common commands

The common commands are taken from the IEEE 488.2 (IEC 625–2) standard. The headers of these commands consist of an asterisk * followed by three letters.

Remote Commands:

***CLS**

CLear Status

Resets the:

- Status byte (`STB`)
- Standard event register (`ESR`)
- `EVENt` part of the `QUEStionable` and the `OPERation` register
- Error/event queue

The command does not alter the `ENABle` and `TRANsition` parts of the registers.

**Usage:** Event

***ESE** <register>

Event Status Enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

**Parameters:**

<register> Range: 0 to 255
*RST: 0

***ESR?**

Event Status Read query

Returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

**Usage:** Query only

***IDN?**

IDeNtification query

Returns a string with information on the sensor's identity (device identification code). In addition, the version number of the installed firmware is indicated.

**Usage:** Query only

***IST?**

Individual STatus query

Returns the current value of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

**Usage:** Query only

***OPC**

OPeration Complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. `*OPC` must be sent at the end of a program message.

The query form returns a "1" when all previous commands have been processed. It is important that the read timeout is set sufficiently long.

Since `*OPC?` waits until all previous commands are executed, "1" is returned in all cases.

`*OPC?` basically functions like the `*WAI` command, but `*WAI` does not return a response.

`*OPC?` is preferred to `*WAI` because with `*OPC?`, the execution of commands can be queried from a controller program before new commands are sent. This prevents overflow of the input queue when too many commands are sent that cannot be executed.

Unlike `*WAI`, `*OPC?` must be sent at the end of a program message.

***OPT?**

OPTion identification query

Returns a comma-separated list of installed options.

**Usage:** Query only

***PRE** <register>

Parallel poll Register Enable

Sets the parallel poll enable register to the specified value or queries the current value.

**Parameters:**

<register> Range: 0 to 255
*RST: 0

***RCL** <number>

ReCaLl

Calls the device state which has been stored with the *SAV command under the specified number.

**Setting parameters:**

| | | |
|---|---|---|
| <number> | Range: | 0 to 9 |
| | *RST: | 0 |

**Usage:** Setting only

***RST**

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command corresponds to the SYSTem:PRESet command.

**Usage:** Event

**Manual operation:** See "Sensor Preset" on page 68

***SAV** <number>

SAVe

Stores the current device state under the specified number. The storage numbers 0 to 9 are available.

**Setting parameters:**

| | | |
|---|---|---|
| <number> | Range: | 0 to 9 |
| | *RST: | 0 |

**Usage:** Setting only

***SRE** <register>

Service Request Enable

Sets the service request enable register to the specified value. This command determines under which conditions a service request is triggered.

**Parameters:**

| | | |
|---|---|---|
| <register> | Range: | 0 to 255 |
| | *RST: | 0 |

***STB?**

STatus Byte query

Returns the contents of the status byte in decimal form.

**Usage:** Query only

***TRG**

TRiGger

Triggers a measurement. This command is only valid if the power sensor is in the waiting for trigger state and the trigger source is set to `BUS`

See`TRIGger:SOURce > BUS` `BUS`.

**Usage:** Event

***TST?**

Selftest query

Triggers a self test of the instrument and outputs an error code in decimal form. `0` indicates that no errors have occurred.

**Example:**
`*TST?`
Query
`0`
Response: Passed
`*TST?`
Query
`1`
Response: Failed

**Usage:** Query only

***WAI**

WAIt to continue

Prevents the execution of the subsequent commands until all preceding commands have been executed and all signals have settled.

**Usage:** Event

# 10.4 Configuring the general functions

## 10.4.1 Configuring the system

The `SYSTem` subsystem contains a series of commands for general functions that do not directly affect the measurement.

### 10.4.1.1 Preset and initialize



**SYSTem:PRESet**

Triggers a sensor reset.

The command corresponds to the *RST command.

**Usage:** Event

**SYSTem:INITialize**

Sets the sensor to the standard state, i.e. the default settings for all test parameters are loaded in the same way as with *RST. The sensor then returns a complete list of all supported commands and parameters. With the command, the remote-control software can automatically adapt to the features of different types of sensors with different functionality.

**Usage:** Event

### 10.4.1.2 Reboot and restart



**SYSTem:REBoot**

Reboots the sensor module.

**Usage:** Event

**Manual operation:** See "Reboot Sensor" on page 68

**SYSTem:RESTart**

Restarts the sensor module.

**Usage:** Event

### 10.4.1.3 Firmware update

See also Section 8, "Firmware update", on page 69.

**SYSTem:FWUPdate** <fwudata>

Loads new operating firmware into the device. Rohde & Schwarz provides new firmware in files with the extension `*.rsu`.

Usually, you find the `*.rsu` file at the Rohde & Schwarz web site. Otherwise, consult the customer support or the product marketing.

In addition, Rohde & Schwarz provides dedicated programs for loading new firmware into a R&S NRPM sensor module (e.g. PureFW).

If you want to integrate a firmware update function in your own application, use the `SYSTem:FWUPdate` command. The parameter of this command is a "Definite Length Arbitrary Block Data", containing the direct copy of the binary `*.rsu` file.

A "Definite Length Datablock" has a pre-defined format.It consist of:

- A '#' sign.
- A single digit indicating the length of the number which represents the size of the binary file
- The binary data.
- An appended delimiter (LF, 0x0a).

**Example:**

If you want to update the firmware of the R&S NRPM, you first need an update file, e.g. `nrpm3_03.10.24062601.rsu`.

Lets assume that this file has a size of 10242884 bytes. To send the file to the sensor module for updating the firmware to the new one, your application must assemble a memory block. The memory block consists of the command, the"Definite Length Block" header, the contents of the `*.rsu` file and a trailing delimiter (0x0a = linefeed).

First, have a look at the size of the binary data; it is 10242884 in this case. This number has eight digits. Now you have all the information to assemble everything:

- The `SYST:FWUP` command
- A blank as a separator.
- The '#' sign.
- The '8' for the length of the file size.
- The '10242884' specifying the size of the file.
- ....... (the contents of the `*.rsu` file)..... .
- 0x0a as a delimiter.

In this example, you would write exactly 10242905 bytes to the sensor module (for example via a 'viWrite()' function).

The result sums up from the values of the above list to:

9 + 1 + 1 + 1 + 8 + 10242884 + 1= 10242905

In a (pseudo) string notation, it is:

```
SYST:FWUP #810242884.........(file content)........ <LF>
```

Where `<LF>` is a single 0x0a character and `........(file content)........` is the direct byte-by-byte contents of the `*.rsu` file.

**Setting parameters:**

<fwudata> <block_data>

**Usage:** Setting only

**Manual operation:** See "Update" on page 68

---

**SYSTem:FWUPdate:STATus?**

While a firmware update is in progress, the LED of the sensors flashes in bright white color. When the firmware update is completed, you can read the result of the update with the `SYST:FWUP:STAT?` command.

The result of the query is a readable string.

**Example:** `SYSTem:FWUPdate:STATus?`
Response: `"Success"`

**Usage:** Query only

**Manual operation:** See "Update" on page 68

### 10.4.1.4 Password management

Manage the passwords to control access to the LAN sensor modules by browser or FTP.

The preconfigured user name and instrument password are *instrument*.

We recommend that you change the preconfigured instrument password before connecting the sensor to a network.



---

**SYSTem:SECurity:PASSword:SECurity** <passwd1>, <passwd2>

Sets a new security password.

The command is restricted to remote control over the USB interface (USBTMC).

**Setting parameters:**

<passwd1> Old security password, entered as a string.

<passwd2> New security password, entered as a string.

**Example:** `SYST:SEC:PASS:SEC "100095","100096"`

**Usage:** Setting only

**SYSTem:SECurity:PASSword:USER** <passwd1>, <passwd2>

Sets a new user password, also called instrument password.

The command is restricted to remote control over the USB interface (USBTMC).

**Setting parameters:**

<passwd1> Old user password, entered as a string.

<passwd2> New user password, entered as a string.

**Example:** `SYST:SEC:PASS:USER "instrument", "rohdeandschwarz"`

**Usage:** Setting only

### 10.4.1.5 Network settings

Requires a sensor module with networking capabilities, an R&S NRPM3N.



**SYSTem:COMMunicate:NETWork[:COMMon]:DOMain** <domain>

R&S NRPM3N LAN sensor modules only

Determines the primary suffix of the network domain.

**Parameters:**

<domain>

**Example:** `SYSTem:COMMunicate:NETWork:COMMon:DOMain "abcd.net"`
Sets *abcd.net* as domain of the network.

**SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname** <hostname>

R&S NRPM3N LAN sensor modules only

Sets an individual hostname for the sensor module.

**Note:** We recommend that you do not change the default hostname to avoid problems with the network connection. If you change the hostname, be sure to use a unique name.

**Parameters:**
<hostname>

**Example:** `SYSTem:COMMunicate:NETWork:COMMon:HOSTname?`
Response: `'nrpm3n-sensormodule2'`

---

**SYSTem:COMMunicate:NETWork:CONFigure** <value>

R&S NRPM3N LAN sensor modules only

Sets a static address. Combines the three commands to set the IP address, the subnet mask and the gateway.

**Setting parameters:**
<value> **"<mode>,<IP address>,<subnet mask>,<gateway>"**
The string has to start with <mode> = STAT. Otherwise, it is ignored.
<IP address> see `SYSTem:COMMunicate:NETWork:IPADdress` on page 104.
<subnet mask> see `SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK` on page 105.
<gateway> see `SYSTem:COMMunicate:NETWork:IPADdress:GATeway` on page 105.

**Example:** `SYST:COMM:NETW:CONF 'STAT, 147.161.235.79,255.255.255.0,192.168.1.200'`

**Usage:** Setting only

---

**SYSTem:COMMunicate:NETWork:IPADdress** <ipaddress>

R&S NRPM3N LAN sensor modules only

For `SYSTem:COMMunicate:NETWork:IPADdress:MODE STATic`, you can set the address manually.

Sets the IP address of the R&S NRPM3N.

**Parameters:**
<ipaddress> Range: 0.0.0.0. to ff.ff.ff.ff

**Example:** `SYSTem:COMMunicate:NETWork:IPADdress "10.113.0.104"`
Sets *10.113.0.104* as IP address.

**Manual operation:** See "IP Address" on page 66

**SYSTem:COMMunicate:NETWork:IPADdress:GATeway** <gateway>

R&S NRPM3N LAN sensor modules only

Sets the IP address of the default gateway.

For `SYSTem:COMMunicate:NETWork:IPADdress:MODE STATic`, you can set the gateway manually.

**Parameters:**
<gateway>

**Example:** `SYSTem:COMMumicate:NETWork:IPADdress:GATeway '192.168.10.254'`
Sets 192.168.10.254 as IP address of the default gateway.

**Manual operation:** See "Gateway" on page 66

**SYSTem:COMMunicate:NETWork:IPADdress:INFO?**

R&S NRPM3N LAN sensor modules only

Queries the network status information.

**Example:** `SYSTem:COMMumicate:NETWork:IPADdress:INFO?`

**Usage:** Query only

**SYSTem:COMMunicate:NETWork:IPADdress:MODE** <mode>

R&S NRPM3N LAN sensor modules only

Sets whether the IP address is assigned automatically or manually.

**Parameters:**
<mode> AUTO | STATic

**AUTO**
Assigns the IP address automatically, provided the network supports DHCP.

**STATic**
Enables assigning the IP address manually.

*RST: AUTO

**Example:** `SYSTem:COMMunicate:NETWork:IPADdress:MODE AUTO`
The IP address is assigned automatically.

**Manual operation:** See "DHCP" on page 67

**SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK** <netmask>

R&S NRPM3N LAN sensor modules only

Sets the subnet mask.

For SYSTem:COMMunicate:NETWork:IPADdress:MODE STATic, you can set the subnet mask manually.

**Parameters:**
<netmask>

**Example:** `SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK '255.255.255.0'`
Sets 255.255.255.0 as subnet mask.

**Manual operation:** See "Subnet Mask" on page 66

---

**SYSTem:COMMunicate:NETWork:RESet**

R&S NRPM3N LAN sensor modules only

Resets the LAN network settings to the default values.

**Example:** `SYSTem:COMMunicate:NETWork:RESet`

**Usage:** Event

---

**SYSTem:COMMunicate:NETWork:RESTart**

R&S NRPM3N LAN sensor modules only

Restarts the network.

**Example:** `SYSTem:COMMunicate:NETWork:RESTart`
Terminates the network connection and sets it up again

**Usage:** Event

---

**SYSTem:COMMunicate:NETWork:STATus?**

R&S NRPM3N LAN sensor modules only

Queries the network configuration state.

**Example:** `SYSTem:COMMunicate:NETWork:STATus?`
Response: 1 The network is active.

**Usage:** Query only

### 10.4.1.6 Remote settings

**SYSTem:HELP:HEADers?** [<Item>]

Returns a list of all SCPI commands supported by the sensor.

**Query parameters:**

<Item> <block_data>

**Usage:** Query only

**SYSTem:HELP:SYNTax:ALL?**

Returns a block data with all SCPIs and the relevant parameter infos for each SCPI.

**Usage:** Query only

**SYSTem:HELP:SYNTax?** [<Item>]

Returns the relevant parameter information for the specified SCPI.

**Query parameters:**

<Item>

**Example:** `SYST:HELP:SYNT? 'sens:aver:coun'`

**Usage:** Query only

**SYSTem:LANGuage** <language>

Selects an emulation of a different command set.

**Parameters:**

<language> SCPI

*RST: SCPI

**SYSTem:PARameters?**

Lists all commands with default values, limits and ranges.

**Usage:** Query only

**SYSTem:PARameters:DELTa?**

Lists all commands that differ from the defined default status set by `*RST`.

The commands are output with default values, limits and ranges.

**Usage:** Query only

**SYSTem:TRANsaction:BEGin**

Starts a series of settings.

**Usage:** Event

**SYSTem:TRANsaction:END**

Ends a series of settings.

**Usage:** Event

**SYSTem:VERSion?**

Queries the SCPI version the sensor's command set complies with.

**Example:** `SYSTem:VERSion?`
Queries the SCPI version.
Response: `1999.0`
The sensor complies with the SCPI version from 1999.

**Usage:** Query only

### 10.4.1.7 Sensor information



**SYSTem:DFPRint<Channel>?**

Reads the footprint file of the sensor module.

**Suffix:**
<Channel> 1...4
Measurement channel if more than one channels are available.

**Usage:** Query only

**SYSTem:INFO?** [<item>]

Returns information about the system.

`SYSTem:INFO?<string_value>` is used to query a specific information item. Without `<string_value>`, the command returns all available information in a list string, separated by commas.

`<string_value>` can query the information to the following system parameters:

- Manufacturer
- Type
- Stock Number
- Serial
- SW Build
- Sensor Name
- Technology
- Function
- System MinPower
- System MaxPower
- System MinFreq
- System MaxFreq
- Resolution
- Cal. Misc.
- Cal. Abs.
- Cal. Temp.
- Cal. Lin.
- System Cal. Due Date
- Antenna 1 Type
- Antenna 1 Stock number
- Antenna 1 Serial
- Antenna 1 Cal. Due Date
- Antenna 1 Property
- Antenna 2 Type
- Antenna 2 Stock number
- Antenna 2 Serial
- Antenna 2 Cal. Due Date
- Antenna 2 Property
- Antenna 3 Type
- Antenna 3 Stock number
- Antenna 3 Serial
- Antenna 3 Cal. Due Date
- Antenna 3 Property
- System Uptime

If no antenna module is connected, the command returns "not present" for all parameters of the corresponding antenna input.

**Query parameters:**
<item>

**Usage:** Query only

---

**SYSTem[:SENSor]:NAME** <sensorname>

Queries the sensor name, or assigns an arbitrary alias name to the sensor.

If not specified, it defaults to the hostname of the sensor module.

**Parameters:**
<sensorname>

**Example:**
```
SYSTem[:SENSor]:NAME "SensorModuleInput_A90D"
SYSTem[:SENSor]:NAME?
```
Queries the sensor name.
Response: `"SensorModuleInput_A90D"`

**Manual operation:** See "Sensor Name" on page 66

### 10.4.1.8 Status display and update

See also "Status LED (2)" on page 25.



---

**SYSTem:LED:CHANnel<Channel>:COLor** <color>

Sets the color of the antenna module LED.

The suffix <channel> selects the corresponding antenna module, and the suffix <color> selects LED on/off.

**Suffix:**

<Channel> 1...3

**Parameters:**

<color>

**0**

The LED is off.

**> 0**

The LED shines blue.

Range: 0 to 255

*RST: 0

---

**SYSTem:LED:COLor** <color>

Sets the color of the sensor module status LED, if the LED operating mode `SYSTem:LED:MODE USER`) is selected.

**Parameters:**

<color> Range: 0 to 0x0FFFFFFF

*RST: 0xA0A0A0

**Example:**

`SYSTem:LED:MODE USER`

Selects "User" mode for the system status LED.

`SYSTem:LED:COLor #HA000A0`

Sets the LED color to magenta.

`SYSTem:LED:COLor #H00C000`

Sets the LED color to green.

`SYSTem:LED:MODE SENSor`

Sets the system status LED operating mode back to the sensor internal settings.

---

**SYSTem:LED:MODE** <mode>

Selects whether the color of the system status LED is controlled by the firmware of the sensor internally or by the user settings.

For more information, see `SYSTem:LED:COLor`.

**Parameters:**

<mode> USER | SENSor

*RST: SENSor

### 10.4.1.9 Measurement limits and levels

**SYSTem:MINPower?**

Yields the lower power measurement limit.

The lower measurement limit refers to the sensor or to the combination of a sensor and the components connected ahead of it. This query can be used to determine a useful resolution for the result display near the lower measurement limit.

**Usage:** Query only

**SYSTem:MINPower:UNIT** <unit>

Sets the unit for the lower power measurement limit, queried by `SYSTem:MINPower?`.

**Parameters:**

<unit> DBM | W | DBUV

*RST: W

**SYSTem:TLEVels?**

Queries the possible power test levels of the sensor module.

**Usage:** Query only

### 10.4.1.10 Errors

See also Section 12, "Troubleshooting", on page 173.



**SYSTem:ERRor:ALL?**

Queries all unread entries in the error/event queue and removes them from the queue. The response is a comma-separated list of error numbers and a short description of the error in the first in first out order.

Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

**Example:** `SYSTem:ERRor:ALL?`

Response: `0,"No Error"`

**Usage:** Query only

**SYSTem:ERRor:CODE:ALL?**

Queries all unread entries in the error/event queue and removes them from the queue. Only the error numbers are returned and not the entire error text.

**Example:** `SYSTem:ERRor:CODE:ALL?`
Response: `0`
No errors occurred since the last read out of the error queue.

**Usage:** Query only

**SYSTem:ERRor:CODE[:NEXT]?**

Queries the oldest entry in the error queue and then deletes it. The query returns only the error number, not the entire error text.

**Example:** `SYSTem:ERRor:CODE?`
Response: `0`
No errors have occurred since the error queue was last read out.

**Usage:** Query only

**SYSTem:ERRor:COUNt?**

Queries the number of entries in the error queue.

**Example:** `SYSTem:ERRor:COUNt?`
Response: `1`
One error occurred since the last read out of the error queue.

**Usage:** Query only

**SYSTem:ERRor[:NEXT]?**

Queries the error/event queue for the oldest item and removes it from the queue. The query returns an error number and a short description of the error.

Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

**Example:** `SYSTem:ERRor?`
Queries the oldest entry in the error queue.
Response: `0,"no error"`
No errors occurred since the last read out of the error queue.

**Usage:** Query only

**SYSTem:SERRor:LIST:ALL?**

Returns a list of all static errors that have occurred but have already been resolved. For example, an overload of a short duration.

**Example:** `SYSTem:SERRor:LIST:ALL?`
Response: `0,"reported at uptime:2942; notice; auto-averaging exceeded maximum time;Notification",0,"removed at uptime:2944; notice; auto-averaging exceededmaximum time; Notification".`

**Usage:** Query only

**SYSTem:SERRor:LIST[:NEXT]?**

Queries the list of all static errors that have occurred but have already been resolved for the eldest entry and removes it from the queue. The response consists of an error number and a short description of the error.

**Example:** `SYST:SERR:LIST?`
Query
Response: `0,"reported at uptime:2942; notice; auto-averaging exceeded maximum time; Notification"`

**Usage:** Query only

**SYSTem:SERRor?**

Returns the next static error (if any). Static errors are more severe than normal error conditions, which can be queried with `SYSTem:ERRor[:NEXT]?`. While normal errors result from, e.g. unknown commands or syntax errors and generally affect a single parameter or setting, the static errors, usually prevent the execution of normal measurements.

**Usage:** Query only

## 10.4.2 Handling of available antenna modules

The `SENSe:CHANnel` subsystem contains commands for checking connected antenna modules, and activating individual antenna modules.

Remote commands:



**[SENSe<Sensor>:]CHANnel<Channel>:PRESence?**

Queries whether an antenna module is connected to a channel.

**Suffix:**

| | |
|---|---|
| <Sensor> | 1 |
| <Channel> | 1...3 |

**Usage:** Query only

**Manual operation:** See "Antenna" on page 62

**[SENSe<Sensor>:]CHANnel<Channel>[:ENABle]** <state>

Deactivates channels without an antenna module connected.

**Note:** A sensor module channel which does not have a connected antenna module causes a static error condition. The static error leads to a blinking LED. Therefore we recommend that you disable unconnected channels by this command.

**Suffix:**

<Sensor> 1

<Channel> 1...3

**Parameters:**

<state> *RST: ON

**Manual operation:** See "Antenna" on page 62

### 10.4.3 Selecting the reference source

The `ROSCillator` subsystem contains commands for configuring the reference source.

**[SENSe<Sensor>:]ROSCillator:SOURce** <source>

Selects the source of the reference frequency.

**Suffix:**

<Sensor> 1

**Parameters:**

<source> INTernal | EXTernal | HOST

**INTernal**
Internal precision oscillator.

**EXTernal | HOST**
External signal supplied at the host interface connector.

*RST: INTernal

**Example:** `ROSCillator:SOURce EXTernal`

### 10.4.4 Setting the power unit

The `UNIT` subsystem contains command for setting up the power unit.

**UNIT:POWer** <unit>

Sets the output unit for the measured power values.

**Parameters:**

<unit> DBM | W

*RST: W

### 10.4.5 Setting the result format

The `FORMat` subsystem sets the format of numeric data (measured values) that is exchanged between the remote control computer and the sensor modules if high-level measurement commands are used.

Remote commands:



---

**FORMat:BORDer** <border>

Selects the order of bytes in 64-bit binary data.

**Parameters:**

<border> NORMal | SWAPped

**NORMal**
The 1st byte is the LSB, the 8th byte the MSB.
This format fulfills the "Little Endian" convention.

**SWAPped**
The 1st byte is the most significant byte (MSB), the 8th byte the least significant byte (LSB).
This format fulfills the "Big Endian" (big end comes first) convention.

*RST: NORMal

---

**FORMat:SREGister** <sregister>

Specifies the format used for the return value of `*STB?`.

**Parameters:**

<sregister> ASCii | HEXadecimal | OCTal | BINary

*RST: ASCii

---

**FORMat[:DATA]** [<data,length>, <length>]

Specifies whether block data is transferred in plain text or binary format.

**Parameters:**

<data,length> ASCii | REAL

**ASCii**
Transmits data as character strings in plain text.

**REAL**
Transmits data in binary blocks with 32 bit or 64 bit length.

*RST: ASCii

<length> Range: 32, 64
*RST: 0

**Example:** `FORMat:DATA REAL,64`
Binary DOUBLE

`FORMat:DATA ASCii,3`
3.124

## 10.5 Controlling the measurement

The sensor module offers a bunch of possibilities to control the measurement:

- Do you want to start the measurement immediately after the initiate command or do you want to wait for a trigger event?
- Do you want to start a single measurement cycle or a sequence of measurement cycles?
- Do you want to retrieve each new average value as a measurement result or do you want to bundle more measured values into one result?

The following chapter introduces in general the principle of triggering and the controlling mechanisms for the output of the measurement results.

### 10.5.1 Triggering

In a basic continuous measurement, the measurement is started immediately after the initiate command. However, sometimes you want that the measurement starts only if a specific condition is fulfilled. For example, if a signal level is exceeded, or in certain time intervals. For these cases, you can define a trigger for the measurement.

**Trigger states**

The sensor module has trigger states to define the exact start and stop times of a measurement and the sequence of a measurement cycle.

The following states are defined:

- Idle
  The sensor module does not execute a measurement. After powered on, the sensor module is in the idle state.
  When a measurement has been started by one of the `INIT` commands, the sensor module switches to the waiting for trigger state.
  See Waiting for a trigger event.
- Waiting for trigger
  The sensor module waits for a trigger event that is defined by the trigger source, see "Trigger sources" on page 117.

When the trigger event occurs, the sensor module enters the measuring state.

- Measuring
  The sensor module is measuring data. It remains in this state during the measurement. When the measurement is completed, the sensor module either continues with the next measurement, or finishes the current measurement and returns to IDLE state, depending on the initial mode you have started the measurement before.

### Waiting for a trigger event

Before a trigger can be executed, you must set the sensor module to the waiting for trigger state. Depending on whether you want to measure continuously or want to execute one dedicated measurement, use the corresponding command:

- `INITiate:CONTinuous` on page 146
  Starts a new measurement cycle automatically after the previous one has been completed.
- `INITiate[:IMMediate]` on page 145
  Starts a single measurement only. Depending on the selected measurement function, a *single measurement* can lead to an array of results, e.g., in trace mode. See `[SENSe<Sensor>:]FUNCtion` on page 125.

### Trigger sources

The possible trigger conditions and the execution of a trigger depend on the selected trigger source.

If the signal power exceeds or falls below a reference level set by the trigger level, the measurement starts after the defined delay time. Waiting for a trigger event can be skipped by selecting `TRIGger:IMMediate`.

| Trigger source | Description | Remote commands to initiate the measurement unconditionally |
|---|---|---|
| Hold | Triggered by the remote command. | `TRIGger:IMMediate` |
| Immediate | Measures immediately, does not wait for trigger condition. | - |
| Internal | Uses the input signal as trigger signal. | `TRIGger:IMMediate` |
| External 1 | Uses the digital input signal supplied using a differential pair in the 8-pin sensor module cable. | `TRIGger:IMMediate` |
| External 2 | Uses the digital input signal supplied at the SMB connector. | `TRIGger:IMMediate` |
| Bus | Triggered by the remote command. | `*TRG`<br>`TRIGger:IMMediate` |

### Dropout time

The dropout time is useful when dealing with signal with several active slots, for example GSM signals, as, e.g., shown in Figure 10-1. When measuring in sync with the signal, a trigger event is to be produced at A, but not at B or C.

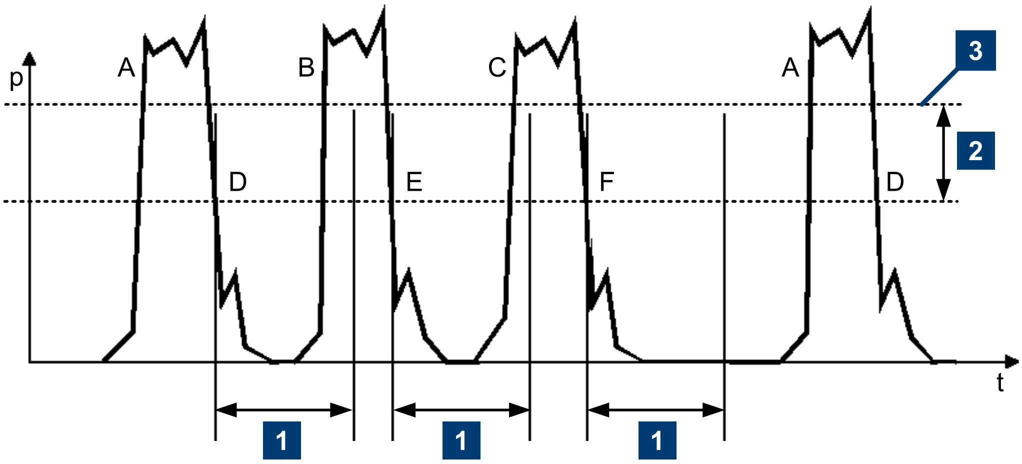



*Figure 10-1: Significance of the drop-out time parameter*

1 = Dropout time
2 = Trigger hysteresis
3 = Trigger level

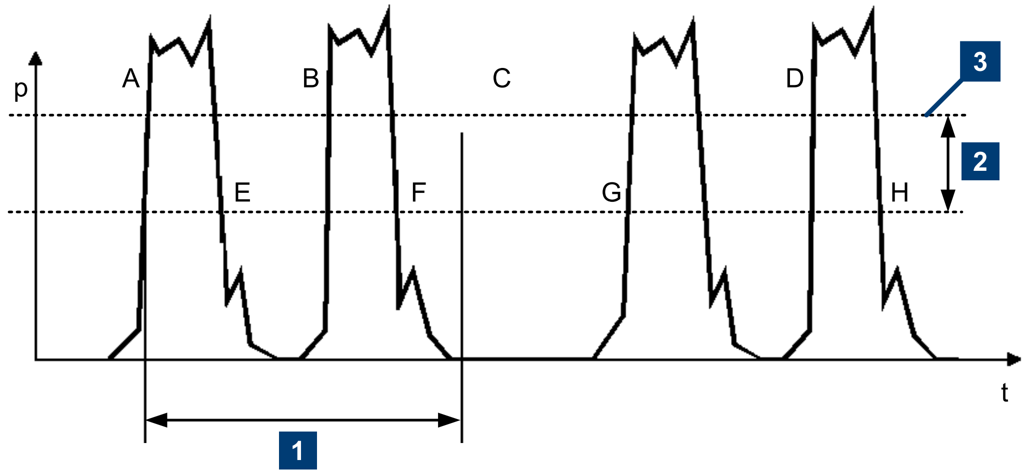
The RF power between the slots is below the threshold defined by the trigger level and the trigger hysteresis. Therefore, the trigger hysteresis alone cannot prevent triggering at B or at C. Therefore, set the dropout time greater than the time elapsed between points D and B and between E and C, but smaller than the time elapsed between F and A. Therefore, ensure that triggering takes place at A.

Because the mechanism associated with the dropout time is reactivated whenever the trigger threshold is crossed, you can obtain also unambiguous triggering for many complex signals.

If you use a hold-off time instead of a dropout time, you can obtain stable triggering conditions - regular triggering at the same point. But you cannot achieve exclusive triggering at A.

### Hold-off time

During the hold-off time, a period after a trigger event, all trigger events are ignored.




1 = Hold-off time
2 = Trigger hysteresis
3 = Trigger level

## 10.5.2 Controlling the measurement results

The R&S NRPM3(N) sensor module can cope with the wide range of measurement scenarios with the help of the so-called "termination control". Depending on how fast your measurement results change, you can define, how to retrieve the measurement results.

In continuous average mode, use `[SENSe<Sensor>:]AVERage:TCONtrol`.

In trace mode, use `[SENSe<Sensor>:]TRACe:AVERage:TCONtrol`.

**Repeating termination control**

Returns a measurement result when the average filter has been filled completely. The number of measurement cycle repetitions is equal to the set average count. If the average count is large, the measurement time can take long time.

Useful if you expect slow changes in the results, and you want to avoid the output of redundant data.

Select repeating termination control when executing remote control applications, as you are usually only interested in the results of the fully settled average filter.

**Moving termination control**

Returns intermediate values to facilitate early detection of changes in the measured quantity. For each partial measurement, the sensor module returns a new average value as an intermediate measurement result. Thus, the individual result is a moving average of the last partial measurements. The parameter average count defines how many partial measurements are included.

Select the moving termination control when you want to observe and detect trends in the results during an ongoing measurement.

## 10.5.3 Interplay of the controlling mechanisms

The following examples use continuous measurement scenarios. But these scenarios apply also to single measurements. The only difference is that a single measurement is not repeated.

### 10.5.3.1 Continuous average mode

General settings for these examples:

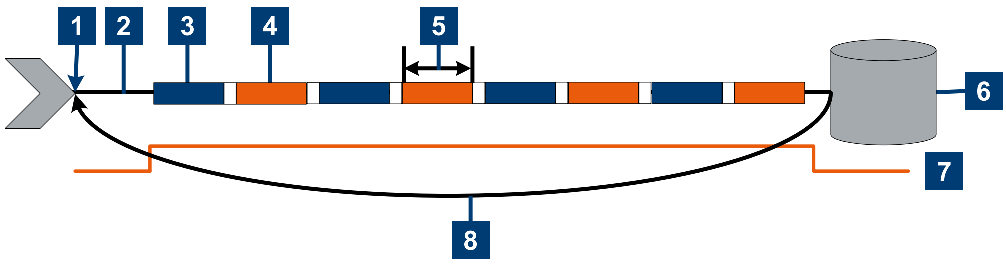
- `INITiate:CONTinuous ON`
- `[SENSe<Sensor>:]AVERage:COUNt 4`
- `[SENSe<Sensor>:]AVERage[:STATe] ON`

**Example: Repeating termination control**

Further settings for this example:

- `[SENSe<Sensor>:]AVERage:TCONtrol REPeat`

The measurement is started by the trigger event. Due to the chopper phases, one measurement lasts twice the defined aperture time. As defined by the average count, after 4 measurements, the result is averaged and available. During the whole measurement cycle, the trigger synchronization is high (`TRIGger:SYNC:STATe ON`).




1 = Start of the measurement cycle
2 = Trigger event
3 = Noninverted chopper phase
4 = Inverted chopper phase
5 = Duration of one aperture time (1 x $t_{AP}$) ≙ length of one chopper phase
6 = Measurement result
7 = Trigger synchronization
8 = Return to the start of the measurement cycle

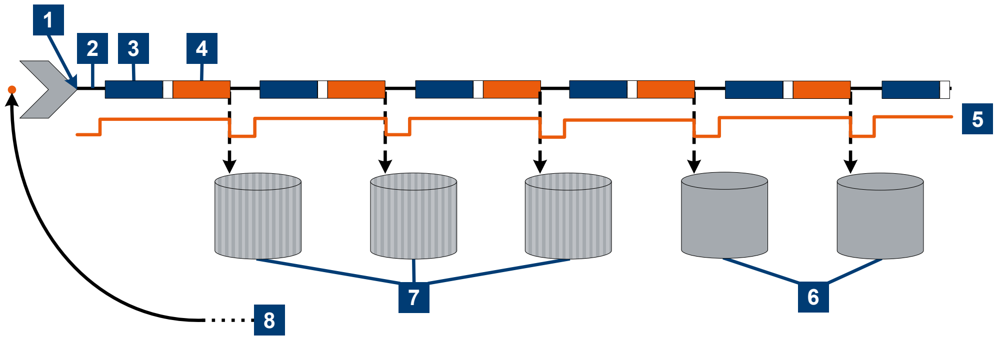
**Example: Moving termination control**

Further settings for this example:

- [SENSe<Sensor>:]AVERage:TCONtrol MOVing
- TRIGger:COUNt 16

Every measurement is started by a trigger event. Due to the chopper phases, one measurement lasts twice the defined aperture time. During each measurement, the trigger synchronization is high (TRIGger:SYNC:STATe ON). Every measurement provides a result. During the settling phase, the amount of the result is already correct, but the noise is higher. After 4 measurements, when the average count is reached, settled data are available.

When the trigger count is reached (TRIGger:COUNt), the sensor module returns to the idle state.

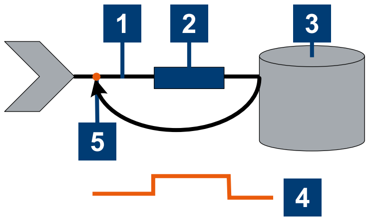



1 = Start of the measurement cycle
2 = Trigger event
3 = Noninverted chopper phase
4 = Inverted chopper phase
5 = Trigger synchronization
6 = Averaged measurement result after average count is reached
7 = Measurement result before average count is reached
8 = Return to idle state after trigger count (= 16 in this example) is reached

**Example: Average count = 1**

[SENSe<Sensor>:]AVERage:COUNt 1

For average count 1, the setting of the termination control has no impact. In both cases, the measurement runs for the duration of one aperture time. Then, settled data are available, and the sensor module returns to the idle state.




1 = Trigger event
2 = Noninverted chopper phase
3 = Measurement result
4 = Trigger synchronization
5 = Return to idle state

### 10.5.3.2 Trace mode

General settings for the first two examples:

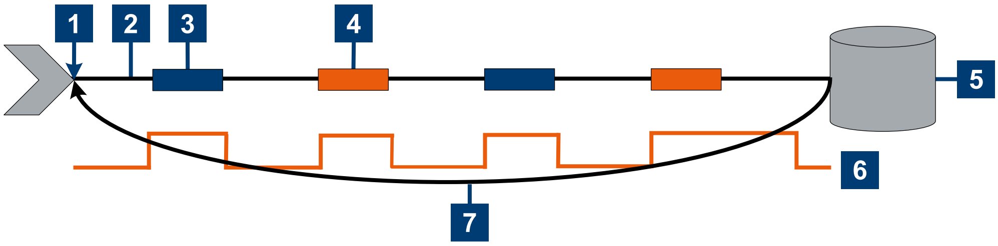
- INITiate:CONTinuous ON
- [SENSe<Sensor>:]TRACe:AVERage:COUNt 2 (count 2 is mandatory in trace mode)
- [SENSe<Sensor>:]TRACe:AVERage[:STATe] ON

**Example: Repeating termination control**

Further settings for this example:

- [SENSe<Sensor>:]TRACe:AVERage:TCONtrol REPeat (termination control REPeat is mandatory in trace mode)

Every chopper phase is started by a trigger event and lasts the defined trace time. During a chopper phase, the trigger synchronization is high (TRIGger:SYNC:STATe ON). After 2 chopper phases, 1 measurement is completed. As defined by the trace average count, after 2 measurements, the trace measurement result is averaged and available.



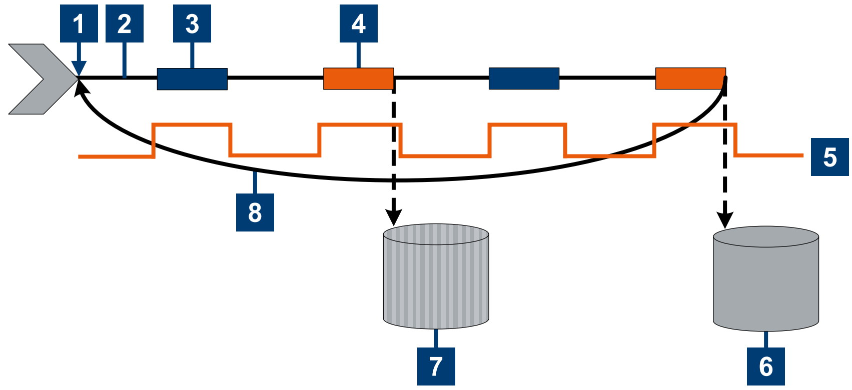

1 = Start of the measurement cycle
2 = Trigger event
3 = Noninverted chopper phase
4 = Inverted chopper phase
5 = Trace measurement result
6 = Trigger synchronization
7 = Return to the start of the measurement cycle

**Example: Moving termination control**

Further settings for this example:

- [SENSe<Sensor>:]TRACe:AVERage:TCONtrol MOVing

Every chopper phase is started by a trigger event and lasts the defined trace time. During a chopper phase, the trigger synchronization is high (TRIGger:SYNC:STATe ON). Every measurement provides a result. After 2 measurements, when the trace average count is reached, settled trace data result is available.

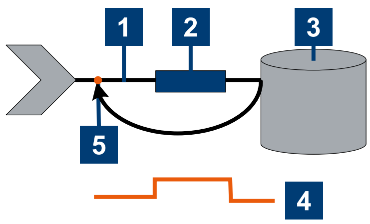



1 = Start of the measurement cycle
2 = Trigger event
3 = Noninverted chopper phase
4 = Inverted chopper phase
5 = Trigger synchronization
6 = Averaged trace data result after trace average count is reached
7 = Trace measurement result before trace average count is reached
8 = Return to the start of the measurement cycle

**Example: Average count = 1**

[SENSe<Sensor>:]TRACe:AVERage:COUNt 1

For average count 1, the setting of the termination control has no impact. In both cases, the measurement runs for the duration of one trace time. Then, settled trace data are available, and the sensor module returns to the idle state.




1 = Trigger event
2 = Noninverted chopper phase
3 = Trace measurement result
4 = Trigger synchronization
5 = Return to idle state

## 10.6 Selecting a measurement mode and retrieving results

Before starting a measurement, select the measurement mode using: `[SENSe<Sensor>:]FUNCtion`.

The following modes are available:

- Continuous average (`"POWer:AVG"`): After a trigger event, the power is integrated over a time interval, see Section 10.7.1, "Configuring a continuous average measurement", on page 129.
- Trace (`"XTIMe:POWer"`): A sequence of measurements is performed, see Section 10.7.3, "Configuring a trace measurement", on page 133.

After measuring, you can query the measurement results with the correspondent `FETCh` command.

**Example: Selecting a measurement mode**

```
*RST

// Select continuous average mode
SENSe:FUNCtion "POWer:AVG"

INITiate
FETCh?
```

Remote commands:



---

**[SENSe<Sensor>:]FUNCtion** <function>

Sets the measurement mode.

**Suffix:**

| | |
|---|---|
| <Sensor> | 1 |

**Parameters:**

| | |
|---|---|
| <function> | **"POWer:AVG"**<br>**Continuous Average**<br>After a trigger event, the power is integrated over a time interval (aperture) set with `[SENSe<Sensor>:][POWer:][AVG:]APERture`. |

**XTIMe:POWer**
**Trace**
In this mode, power over time is measured. Therefore several measurement points are defined ([SENSe<Sensor>:]TRACe:POINts) where the length of an individual measurement is determined from the ratio of total time ([SENSe<Sensor>:]TRACe:TIME) and the defined number of measurement points.

*RST: "POWer:AVG"

**FETCh<Channel>[:SCALar][:POWer][:AVG]?**

Queries the measurement results of a particular channel of the sensor module.

**Suffix:**
<Channel> 1...3

**Usage:** Query only

**FETCh<Sensor>:ALL[:SCALar][:POWer][:AVG]?**

Queries the measurement results of all channels of a sensor module.

The sensor module returns the results in a string, separated by commas.

**Suffix:**
<Sensor> 1

**Usage:** Query only

**CALCulate:FEED** <mode>

When you query measurement data using FETCh<Channel>[:SCALar][:POWer][:AVG]?, the sensor module returns data of the measurand that was configured before, but it can also return data of different measurands. By default, the reading is the average power.

To determine the measurand for the FETCh<Channel>[:SCALar][:POWer][:AVG]? command, use the CALCulate:FEED before initiating the measurement.

Depending on the measurement mode, the following settings are possible:

| SENS:FUNC | Possible CALC:FEED | Meaning |
|---|---|---|
| "POWer:AVG" | "POWer:AVERage" | Average value |
| | "POWer:PEAK" | Peak value |
| | "POWer:RANDom" | Randomly selected value from the measurement interval |
| "XTIMe:POWer" | "POWer:TRACe" | Measurement sequence |

| SENS:FUNC | Possible CALC:FEED | Meaning |
|---|---|---|
| | "POWer:PEAK:TRACe" | Peak value of the samples per trace point |
| | "POWer:RANDom:TRACe" | Randomly selected value of the samples per trace point |

**Parameters:**
<mode> *RST: "POWer:AVERage"

**Example:** The following sequence of commands configures a peak trace measurement:

```
SENSe:FUNCtion "XTIMe:POWer"
SENSe:FREQuency 1.0e9
SENSe:TRACe:POINts 500
SENS:TRAC:TIME 20e-3
TRIGger:SOURce INTernal
TRIGger:SLOPe POSitive
TRIGger:DTIMe 0.001
TRIGger:HYSTeresis 0.1
TRIGger:LEVel 30e-6
SENSe:TRACe:AVERage:COUNt 8
SENSe:TRACe:AVERage:STATe ON
CALCulate:FEED "POWer:PEAK:TRACe"
INITiate
FETCh?
```

**CALCulate:MATH[:EXPRession]** <mode>

Selects the measurement quantity for the power of the incident electromagnetic wave towards the antenna module.

| String | Meaning |
|---|---|
| "PISotropic" | Equivalent isotropically received power $P_{ISO}$ in W or dBm (default):<br>Equivalent detected power of an isotropic antenna with an ideal power detector at the phase center location of the R&S NRPM antenna module assuming radiation only from boresight direction.<br>$P_{ISO}=P_i$ |
| "PDENsity" | Power density S in W/m², calculated as:<br>$S=(4\pi/\lambda^2)\cdot P_{ISO}$ |
| "EFDensity" | Electric field strength $E_{eff}$ in V/m, calculated as:<br>$E_{eff}=\sqrt{(S\cdot Z_0)}$ with: $Z_0$=376,73 Ω. |

| String | Meaning |
|---|---|
| "MFDensity" | Magnetic field strength $H_{eff}$ in A/m, calculated as:<br>$H_{eff}=\sqrt{(S/Z_0)}$ with: $Z_0$=376,73 Ω. |
| "DETPower" | Power at the internal RF detector in W or dBm: The measurement result without including antenna gain and frequency-dependent calibration factors is returned.<br>$P_{Det}=(G_{RF,i}/k_{att,A,i}(f))\cdot P_{ISO}$ |

**Parameters:**

<mode> *RST: "PIsotropic"

**Example:** `CALC:MATH "PDEN"`
Selects power density in W/m² as the equivalent resulting unit.

### CALCulate:MATH[:EXPRession]:CATalog?

Lists all supported calculation functions.

The result is a list of strings, separated by comma.

**Example:** `CALC:MATH:CAT?`
Response: `"PISotropic","PDENsitiy","EFDensity","MFDensity","DETPower"`

**Usage:** Query only

### [SENSe<Sensor>:]AUXiliary <mode>

Activates the measurement of additional measurands that are determined together with the main measured value.

**Suffix:**

<Sensor> 1

**Parameters:**

<mode> NONE | MINMax | RNDMax

**NONE**
No additional values are measured.

**MINMax**
In addition to the average trace, the sensor module also determines the minimum and maximum traces. You can read out the resulting traces (min & max) afterwards with the command `[SENSe<Sensor>:]TRACe:DATA??`.

**RNDMax**
Determines a trace of randomly selected samples within the min & max range instead of the minimum trace. You can read out the resulting traces (random & max) afterwards with the command `[SENSe<Sensor>:]TRACe:DATA??`.

*RST: NONE

# 10.7 Configuring the measurement modes

The following chapter describes the settings needed for configuring a measurement mode.

## 10.7.1 Configuring a continuous average measurement

The "Continuous Average" mode measures the signal average power asynchronously within definable time intervals (sampling windows). The aperture time (width of the sampling windows) can be defined.

**Reducing noise and zero offset**

The continuous average measurement can be performed with chopper stabilization to obtain more accurate results with reduced noise and zero offset. When chopper stabilization is used, a single measurement is performed over two sampling windows, the polarity of the detector output signal being reversed for the second window. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized.

The smoothing filter can further reduce result fluctuations caused by modulation. But when activated it increases the inherent noise of the sensor module by approx. 20%, so it should remain deactivated if it is not required.

**Configuring continuous average measurements of modulated signals**

When measuring modulated signals in continuous average mode, the measurement can show fluctuation due to the modulation. If that is the case, adapt the size of the sampling window exactly to the modulation period to get an optimally stable display. If the modulation period varies or is not precisely known, you can also activate the smoothing function.

With smoothing activated, the selected sampling window has to be 5 to 9 times larger than the modulation period for the fluctuations caused by modulation to be sufficiently reduced. The sampling values are subjected to weighting (raised-von-Hann window), which corresponds to video filtering.

If you deactivate the smoothing filter, 300 to 3000 periods are required to obtain the same effect. The sampling values are considered equivalent and averaged in a sampling window, which yields an integrating behavior of the measuring instrument. To obtain optimum suppression of variations in the result, exactly adapt the modulation period to the size of the sampling window. Otherwise, the modulation can have a considerable influence, even if the sampling window is much larger than the modulation period.

**Calculating the measurement time**

The measurement time is calculated as follows:

$MT = 2 * AC * APER + (2 * AC - 1) * 100\ \mu s$

with:

MT: overall measurement time

AC: average count

APER: aperture time

100 µs is the time for switching the chopper phase.

Remote commands:



**[SENSe<Sensor>:][POWer:][AVG:]APERture** <integration_time>

Sets the aperture, sampling window (time interval) for the continuous average mode. The aperture time defines the length of the unsynchronized time interval used to measure the average signal power.

**Suffix:**
<Sensor> 1

**Parameters:**
<integration_time> Range: 10.0e-6 s to 2.00 s
*RST: 0.02 s
Default unit: s

**Manual operation:** See "Aperture Time" on page 60

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:CLEar**

Erases the contents of the result buffer continuous average mode.

**Suffix:**
<Sensor> 1

**Example:** `[SENSe1:][POWer:][AVG:]BUFFer:CLEar`

**Usage:** Event

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:COUNt?**

Available in continuous average mode.

Queries the number of results that are currently saved in the result buffer.

**Suffix:**
<Sensor> 1

**Example:** `[SENSe1:][POWer:][AVG:]BUFFer:COUNt?`

**Usage:** Query only

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:DATA?**

Queries the data of the continuous average result buffer and returns them even if the buffer is not full.

In contrast,`FETCh<Channel>[:SCALar][:POWer][:AVG]?` returns a result only if the buffer is full.

**Suffix:**
<Sensor> 1

**Example:** [SENSe1:][POWer:][AVG:]BUFFer:DATA?

**Usage:** Query only

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:INFO?** [<ITEM>]

Queries the data of the continuous average result buffer.

**Suffix:**
<Sensor> 1

**Query parameters:**
<ITEM>

**Example:** `[SENSe1:][POWer:][AVG:]BUFFer:INFO?`

**Usage:** Query only

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:SIZE** <count>

Sets the size of the result buffer in continuous average mode.

You can enable the buffer using `[SENSe<Sensor>:][POWer:][AVG:]BUFFer:STATe`.

**Suffix:**
<Sensor> 1

**Parameters:**
<count> Range: 1 to 8192
*RST: 1

**Example:** `[SENSe<Sensor>:][POWer:][AVG:]BUFFer:SIZE 10`

**[SENSe<Sensor>:][POWer:][AVG:]BUFFer:STATe** <state>

Enables or disables the buffered continuous average mode. If the buffer mode is enabled, all results generated by trigger events are collected in the sensor module until the buffer is filled.

You can set the size of the buffer using [SENSe<Sensor>:][POWer:][AVG:]BUFFer:SIZE.

**Suffix:**

<Sensor> 1

**Parameters:**

<state> *RST: OFF

**Example:** `[SENSe<Sensor>:][POWer:][AVG:]BUFFer:STATe OFF`

---

**[SENSe<Sensor>:][POWer:][AVG:]SMOothing:STATe** <state>

Activates the smoothing filter, a steep-edge digital lowpass filter. If you cannot adjust the aperture time exactly to the modulation period, the filter reduces result fluctuations caused by modulation.

**Suffix:**

<Sensor> 1

**Parameters:**

<state> ON | OFF

*RST: OFF

**Example:** `SMOothing:STATe OFF`

**Manual operation:** See "Smoothing" on page 60

## 10.7.2 Configuring a list mode measurement

The list mode measurement enables you to execute a sequence of measurements at various frequency points in continuous average mode automatically.

Remote commands:



---

**[SENSe<Sensor>:]LIST:FREQuency** <frequency>...

Sets the frequency values for list processing mode.

**Suffix:**

<Sensor> 1

**Parameters:**

<frequency> Range: 0 Hz to 110e9 Hz

*RST: 10e9 Hz

Default unit: Hz

**Example:** `[SENSe1:]LIST:FREQuency 40e09,45e09,58e09,75e09`

**[SENSe<Sensor>:]LIST:FREQuency:POINts?**

Sets the number (points) of frequency entries in list processing mode.

**Suffix:**
<Sensor> 1

**Example:** `[SENSe1:]LIST:FREQuency:POINts 4`

**Usage:** Query only

**CONTrol<Sensor>:FREQuency:MODE** <mode>

Selects the frequency list mode.

**Suffix:**
<Sensor> 1

**Parameters:**
<mode> FIXed | RXList
*RST: FIXed

**Example:** `CONTrol1:FREQuency:MODE RXList`

## 10.7.3 Configuring a trace measurement

The trace measurement is used to acquire the course of power over a certain time. During the measurement time ( `[SENSe<Sensor>:]TRACe:TIME`) a large number of measurements are made and the result is returned to the user as an array of values with a predefined size `[SENSe<Sensor>:]TRACe:POINts`. The length of an individual measurement(-point) is determined from the ratio of measurement time and measurement points. The entire result is called a "trace". Each trace must be triggered separately.

Remote commands:



**[SENSe<Sensor>:]TRACe:AVERage:COUNt** <count>

Sets the trace filter length, i.e. the number of acquired traces which are to be averaged for one trace. The higher the count the lower the noise and the longer it takes to obtain a trace result.

**Suffix:**
<Sensor> 1

**Parameters:**
<count> Range: 1 to 65536
*RST: 4

---

**[SENSe<Sensor>:]TRACe:AVERage:TCONtrol** <mode>

Sets the termination control mode for trace mode, defining how you retrieve the measurement results.

When a new intermediate trace is shifted to the FIR filter, a new average trace is available at the filter output. It is composed of the last acquired trace and the other trace data already stored in the filter.

See Section 10.5.2, "Controlling the measurement results", on page 119.

**Suffix:**
<Sensor> 1

**Parameters:**
<mode> MOVing | REPeat

**MOVing**
Returns each new average trace as a measurement result, even if the FIR filter is not yet filled completely with measured traces.
This mode is suitable for measurements, where tendencies in the result have to be recognized during the measurement procedure.

**REPeat**
Returns a final trace result only after the FIR filter has been filled with acquired traces.
This mode is suitable to avoid redundant results in measurements.

*RST: REPeat

**Example:** `TRACe:AVERage:TCONtrol REPeat`

---

**[SENSe<Sensor>:]TRACe:AVERage[:STATe]** <state>

Activates the averaging filter in trace mode.

**Suffix:**
<Sensor> 1

**Parameters:**
<state> *RST: ON

### [SENSe<Sensor>:]TRACe:DATA?

Returns the measured trace data in a pre-defined format. Unlike the FETCh? command, this command considers the settings of [SENSe<Sensor>:]AUXiliary on page 128 as explained below.

**Command response**

Besides the average power, the R&S NRPM sensor module can measure additional measurands like "Minimum", "Maximum" or "Random". These additional measurands are denoted as auxiliary measurands and are selected by the [SENSe<Sensor>:]AUXiliary on page 128 command.

A trace measurement with the R&S NRPM can therefore be configured to return up to three measurands on each channel/antenna module. As a consequence, the resulting data which is provided by a [SENSe<Sensor>:]TRACe:DATA query can contain between 1 and 9 blocks of measurement data. For example, 1 resulting measurement data block if only one antenna module is used and only average power is to be measured on that channel. 9 resulting measurement data blocks if three antenna modules are used and average, min & max power is to be measured on each channel.

To obtain a single measurement data block, you must first extract the contents of the "Definite Length Arbitrary Block" which is returned from the SENSe:TRACe:DATA query. The format is defined in IEEE488.2.

In principle the response has the format as shown in Figure 10-2:

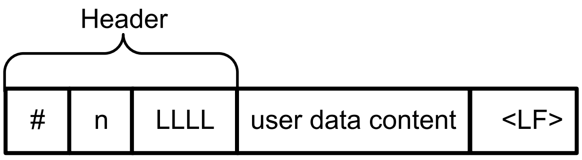



*Figure 10-2: Response format*

| | | |
|---|---|---|
| Header | # | Starting character |
| | n | Single digit that defines how many of the following digits are interpreted as the size of the content. |
| | LLLLL | Number consisting of as many digits as specified by "n". This number determines the size of the content. |
| User data content | | See Figure 10-3. As many bytes as specified by "LLLLL". |
| <LF> | | Single linefeed character |

**Example:**

The arbitrary block response data for a user data that contains 45182 bytes is:

```
#545182xxxxxx.......xxxxxx <LF>
```

The arbitrary block response data for a user data content 'THIS IS A TEST' is:

```
#214THIS IS A TEST<LF>
```

Explanation: `'THIS IS A TEST'` has 14 bytes, and '14' has 2 digits, hence the `#214`.

**User-data-content**

In the further description, the term "user data content" is used for the totality of the contained measurement results.

In the user data content, there are similar mechanisms as with arbitrary block response data. As indicated above, the user data content can have one or more blocks with trace measurement results, depending on the selection of auxiliary measurands. Each section is composed of:

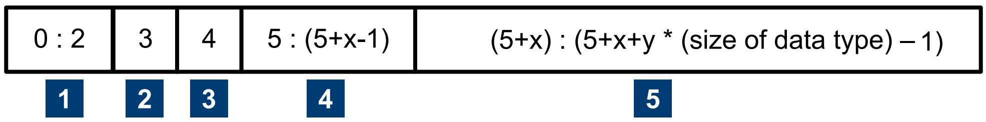



*Figure 10-3: User data content format (byte)*

y = number of values which follow the header
x = number of digits of y

| | |
|---|---|
| 1 | Result type<br>Always 3 bytes, one for `AVG`, one for `MIN` and one for `MAX` or `RND` |
| 2 | Data type<br>Designator for the contained data type with the size of 1 byte. Currently, the only possible designator is "f" for 4-byte IEEE754 float data type, little endian. |
| 3 | Single digit that defines how many of the following digits are interpreted as the number of contained float values. |
| 4 | User data length<br>Number consisting of as many digits as specified by (3). This number gives the number of contained float values contained in the user data. |
| 5 | User data<br>Measurement result values in the format that is described by the data type. Currently IEEE754 float only. |

**Suffix:**
<Sensor> 1

**Example:**

```
C1Af3260xxxxyyyy
C1                  Channel 1
  A                 The letter 'A' to denote
                      the Average-Trace
   f                The letter 'f' to denote
                      float format
    3               3 bytes for length of the number
                      of points that follows
     260            260 float values (4 bytes each)
        xxxxyyyy... 260 float values...
```

This example shows one of up to nine measurement data blocks which could be contained in the user data content. Referring to the example above, if the min and max traces are also selected (by `SENS:AUX MINMAX`) the subsequent data would contain:

```
C1mf3260mmmmnnnn
C1                  Channel 1
  m                 The letter 'm' to denote
                      the Min-Trace
   f                The letter 'f' to denote
                      float format
    3               3 bytes for length of the
                      number of points that follows
     260            260 float values (4 bytes each)
        mmmmnnnn... 260 float values...

C1Mf3260gggghhhh
C1                  Channel 1
  M                 The letter 'M' to denote
                      the Max-Trace
   f                The letter 'f' to denote
                      float format
    3               3 bytes for length of the
                      number of points that follows
     260            260 float values (4 bytes each)
        gggghhhh... 260 float values...
```

For further information, see the `...[NRPM3]\Trace-M3\Visa\visaTraceBinaryData-M3` project from the accompanying programming examples (included). The source-code shows how to extract the measurement data from the "user-data-content".

**Usage:** Query only

**[SENSe<Sensor>:]TRACe:MPWidth?**

Queries the attainable time resolution of the trace mode. The result is the smallest possible distance between two pixels, i.e. it is the smallest time interval that can be assigned to a pixel.

**Suffix:**
<Sensor> 1

**Usage:** Query only

---

**[SENSe<Sensor>:]TRACe:OFFSet:TIME** <time>

Sets the relative position of the trigger event in relation to the beginning of the trace measurement sequence. It is used to specify the start of recording for trace mode.

The start of recording is referenced to the delayed trigger point that is set with `TRIGger:DELay`. Negative values indicate that the start of recording occurs before the trigger point.

**Suffix:**
<Sensor> 1

**Parameters:**
<time> Range: -3.0 s to 3.0 s
*RST: 0.0 s
Default unit: s

**Manual operation:** See "Trace Offset Time" on page 61

---

**[SENSe<Sensor>:]TRACe:POINts** <points>

Sets the number of required values per trace sequence.

**Suffix:**
<Sensor> 1

**Parameters:**
<points> Range: 1 to 100000
*RST: 260

**Manual operation:** See "Trace Points" on page 61

---

**[SENSe<Sensor>:]TRACe:REALtime** <state>

Activates realtime processing of the trace mode.

If disabled, each measurement from the sensor module is averaged. If enabled, only one sampling sequence per measurement is recorded, thus increasing the measurement speed. With a higher measurement speed, the measured values of an individual measurement are immediately delivered.

The averaging filter is not used, i.e. the following settings are ignored:

- `[SENSe<Sensor>:]TRACe:AVERage[:STATe]`
- `[SENSe<Sensor>:]TRACe:AVERage:COUNt`

**Suffix:**
<Sensor> 1

**Parameters:**
<state> *RST: OFF

**[SENSe<Sensor>:]TRACe:TIME** <time>

Sets the trace length, i.e. the time to be covered by the trace sequence. This time period is divided into several equal intervals, in which the average power is determined. The number of intervals equals the number of trace points, which is set with the command `[SENSe<Sensor>:]TRACe:POINts`.

**Suffix:**
<Sensor> 1

**Parameters:**
<time> Range: 10.0e-6 s to 3.0 s
*RST: 0.01 s
Default unit: s

**Manual operation:** See "Trace Time" on page 61

**[SENSe<Sensor>:]TRACe:UPSample[:TYPE]** <type>

Selects an output mode for the acquired trace data.

**Suffix:**
<Sensor> 1

**Parameters:**
<type> SINC | HOLD

**HOLD**
Returns the trace data unchanged. The course of power over time is represented as sampled by the sensor module's data acquisition and processing logic.

**SINC**
Returns the trace data as the result of a SINC interpolation of the acquired samples. This setting is only reasonable if the selected number of trace points is higher than the number of samples which results from the internal sample rate in the selected trace time. The SINC interpolation reconstructs the original signal sequence best from the sampled values. Use it to get a smooth resulting curve.

*RST: SINC

**Example:**
`SENS:TRAC:TIME 100E-6`
Sets the trace time to 100 µs. With an internal sample rate of 2 MHz, the sensor module performs 200 measurements.
`SENS:TRAC:POIN 400`
`SENS1:TRACe:UPS:TYPE SINC`
If you select the number of trace points higher than the number of physical measurements, you achieve a smooth result curve using the `SINC` interpolation.

`SENS:TRAC:POIN 200`
`SENS1:TRACe:UPS:TYPE SINC`
If the trace points are up to the number of physical measurements, the `SINC` interpolation does not affect the trace results.

## 10.8 Configuring basic measurement parameters

The following section describes the settings common for several measurement modes.

### 10.8.1 Configuring averaging

This chapter includes the commands required for averaging in the continuous average measurements.

Remote commands:



**[SENSe<Sensor>:]AVERage:COUNt** <count>

Sets the number of readings that are averaged for one measured value. The higher the count, the lower the noise, and the longer it takes to obtain a measured value.

Average count is often also called averaging factor, but it designates the same parameter, i.e the number of measured values that have to be averaged for forming the measurement result.

Averaging is only effective, when `[SENSe<Sensor>:]AVERage[:STATe]` is turned on.

**Suffix:**

| | |
|---|---|
| <Sensor> | 1 |

**Parameters:**

| | | |
|---|---|---|
| <count> | Range: | 1 to 65536 |
| | *RST: | 4 |

**Example:** `AVERage:COUNt 4`

**Manual operation:** See "<Value>" on page 63

**[SENSe<Sensor>:]AVERage:RESet**

Deletes all previous measurement results that the averaging filter contains and initializes the averaging filter. The filter length gradually increases from 1 to the set averaging factor. Thus, trends in the measurement result become quickly apparent. Note that the measurement time required for the averaging filter to settle completely remains unchanged.

Use this command if:

- A high averaging factor is set.
  `[SENSe<Sensor>:]AVERage:COUNt`
- Intermediate values are output as measurement results.
  `[SENSe<Sensor>:]AVERage:TCONtrol MOVing`.
- Power has significantly decreased since the previous measurement, for example by several powers of 10.

In this case, previous measurement results still contained in the averaging filter strongly affect the settling of the display. As a result, the advantage of detecting trends in the measurement result while the measurement is still in progress, is lost.

**Suffix:**
<Sensor> 1

**Example:** `AVERage:RESet`

**Usage:** Event

**[SENSe<Sensor>:]AVERage:TCONtrol** <mode>

Sets the termination control mode for averaging mode, defining how you retrieve the measurement results.

When a new measured value is shifted to the FIR filter, a new average value is available at the filter output. It is composed of the last measured value and the other values already stored in the filter.

See Section 10.5, "Controlling the measurement", on page 116.

**Suffix:**
<Sensor> 1

**Parameters:**
<mode> MOVing | REPeat

**MOVing**
Provides every new average value at the output as a measurement result.
This mode is suitable for measurements, where tendencies in the result have to be recognized during the measurement procedure.

**REPeat**
A new result is output after the FIR filter has been filled with new measured values.
This mode is suitable for measurements, where no redundant information has to be output.
*RST: REPeat

**Example:** `AVERage:TCONtrol REPeat`

**Manual operation:** See "Filter Terminal Control" on page 63

---

**[SENSe<Sensor>:]AVERage[:STATe]** <state>

Activates the averaging filter for the continuous average mode.

**Suffix:**
<Sensor> 1

**Parameters:**
<state> *RST: ON

**Manual operation:** See "<Mode>" on page 63

## 10.8.2 Setting the frequency

The frequency of the signal to be measured is not automatically determined. For achieving better accuracy, the carrier frequency of the applied signal must be set.



---

**[SENSe<Sensor>:]FREQuency** <frequency>

Transfers the carrier frequency of the RF signal to be measured. This frequency is used for the frequency-response correction of the measurement result.

The center frequency is set for broadband signals, e.g. spread-spectrum signals, multicarrier signals.

The data of the connected antenna module determines the frequency limits.

**Suffix:**
<Sensor> 1

**Parameters:**
<frequency> Range: antenna-specific
*RST: 10.0e9 Hz
Default unit: Hz

**Example:** `FREQuency 4.2e10`

**Manual operation:** See "Frequency" on page 59

**[SENSe<Sensor>:]RANGe** <range>

In trace measurement mode, this command can be used to select a certain antenna module for reading the trace data.

There is also the possibility to read the data of **all** measured trace channels, see `[SENSe<Sensor>:]TRACe:DATA?` on page 135.

**Suffix:**

| | |
|---|---|
| <Sensor> | 1 |

**Parameters:**

| | | |
|---|---|---|
| <range> | Range: | 0 to 2 |
| | *RST: | 0 |

## 10.8.3 Configuring corrections

It is possible to set some parameters that compensate for a change of the measured signal due to fixed external influences.



### 10.8.3.1 Duty cycle corrections

The duty cycle is the percentage of one period in which the signal is active, when pulse-modulated signals are corrected. The duty cycle is only evaluated in the Continuous Average mode.

Remote commands:



**[SENSe<Sensor>:]CORRection:DCYCle** <duty_cycle>

Effective in continuous average mode.

Sets the duty cycle for measuring pulse-modulated signals. The duty cycle defines the percentage of one period when the signal is active.

If the duty cycle is enabled, the R&S NRPM calculates the signal pulse power from the average power considering the duty cycle in percent.

**Suffix:**

| | |
|---|---|
| <Sensor> | 1 |

**Parameters:**

| | | |
|---|---|---|
| <duty_cycle> | Range: | 0.001 percent to 100.00 percent |
| | *RST: | 1.00 percent |
| | Default unit: | PCT |

**Example:** `CORRection:DCYCle 0.01`

**Manual operation:** See "Duty Cycle" on page 60

**[SENSe<Sensor>:]CORRection:DCYCle:STATe** <state>

Activates the duty cycle correction for the measured value.

**Suffix:**
<Sensor> 1

**Parameters:**
<state> *RST: OFF

**Example:** `CORRection:DCYCle:STATe ON`

**Manual operation:** See "Duty Cycle" on page 60

### 10.8.3.2 Offset corrections

The offset accounts for external losses by adding a fixed level offset in dB.

The attenuation of an attenuator located ahead of the sensor module (or the coupling attenuation of a directional coupler) is considered with a positive offset, i.e. the sensor module calculates the power at the input of the attenuator or the directional coupler. You can use a negative offset to compensate the influence of an upstream amplifier.

Remote commands:



**[SENSe<Sensor>:]CORRection:OFFSet** <offset>

Sets a fixed offset that is added to correct the measured value.

**Suffix:**
<Sensor> 1

**Parameters:**
<offset> Range: -200.00 dB to 200.00 dB
*RST: 0 dB
Default unit: dB

**Example:** `CORRection:OFFSet 2`

**Manual operation:** See "<Value>" on page 59

**[SENSe<Sensor>:]CORRection:OFFSet:STATe** <state>

Activates the offset correction.

**Suffix:**
<Sensor> 1

**Parameters:**
<state> *RST: OFF

**Example:** `CORRection:OFFSet:STATe ON`

**Manual operation:** See "<State>" on page 59

## 10.9 Starting and ending a measurement



**ABORt**

Immediately interrupts the current measurement.

Depending on the selected measurement mode, the trigger system of the sensor module exits the measuring state and switches to:

- Idle state
  If a single measurement was previously initiated with command `INITiate[:IMMediate]`, or `INITiate:ALL`.
- Waiting for trigger
  If a continuous measurement was initiated with `INITiate:CONTinuous ON`.
  The sensor module starts the next measurement when a trigger event occurs that meets the set trigger conditions.

**Usage:** Event

**INITiate:ALL**
**INITiate[:IMMediate]**

Starts a single measurement cycle. The sensor module changes from the idle state to the wait for trigger state. When the trigger condition is fulfilled, the sensor module starts measuring. Depending on the number of trigger events that are required, e.g. for averaging, the sensor module enters the wait for trigger state several times. When the entire measurement is completed, the measurement readings are available, and the sensor module returns to the idle state.

Use the command only after the continuous measurement mode has been turned off (`INITiate:CONTinuous OFF`).

**Example:** See Section 11.2, "Performing measurements in continuous average mode", on page 159.

**Usage:** Event

**INITiate:CONTinuous** <state>

Activates the continuous measurement mode. In continuous measurement mode, the sensor module does not change to idle state after a measurement cycle has been completed, but enters the wait for trigger state. When a trigger event occurs, it starts the next measurement cycle. This mode is also known as free-running mode, although each measurement cycle depends on the trigger conditions.

**Parameters:**

<state>

**ON**
Measures continuously. If a measurement is completed, the sensor module enters the wait for trigger state again.

**OFF**
Stops the continuous measurement mode. The sensor module switches to idle state.

*RST: OFF

**Example:** See Section 11.2, "Performing measurements in continuous average mode", on page 159.

**Manual operation:** See "Measurement" on page 58

## 10.10 Configuring the trigger

Further information:

- Section 10.5, "Controlling the measurement", on page 116

Remote commands:

**TRIGger:BURSt:DELay** <delay>

List processing mode only

Sets the initial delay after the start burst until the first measurement starts.

**Parameters:**

| | |
|---|---|
| <delay> | Range: 10e-6 to 1 s<br>*RST: 1e-3 s<br>Default unit: s |

**Example:** `TRIGger:BURSt:DELay 2e-3`

**TRIGger:ATRigger:DELay** <delay>

For `TRIGger:ATRigger[:STATe] ON`, this parameter determines after which time an artificial trigger event is created, if no real trigger event has occurred.

**Parameters:**

| | |
|---|---|
| <delay> | Range: 250e-6 s to 5.0 s<br>*RST: 0.3 s<br>Default unit: s |

**TRIGger:ATRigger:EXECuted?**

Queries the number of measurements which were triggered automatically, provided `TRIGger:ATRigger[:STATe]` is activated.

In scalar measurements, this number can only be 0 or 1. If you execute a buffered measurement the number indicates how many results in the returned array of measurement data were executed without a real trigger event.

**Usage:** Query only

**TRIGger:ATRigger[:STATe]** <state>

Activates the artificial trigger.

An artificial trigger is generated if the time set with `TRIGger:ATRigger:DELay` has elapsed after the start of measurement and no trigger event has occurred.

**Parameters:**

| | |
|---|---|
| <state> | *RST: OFF |

**Example:** `TRIG:ATR:STAT ON`

**TRIGger:COUNt** <count>

Sets the number of measurement cycles to be performed when the measurement is started. This number equals the number of results which can be obtained from the sensor module after a single `INITiate[:IMMediate]`. As long as the defined number of measurements are not yet executed, the sensor module automatically initiates another measurement internally after the current result is available.

Use this command in particular in conjunction with buffered measurements, for example, to fill a buffer with a predefined size with measurements which have been triggered with the command `*TRG` or with the configured trigger condition.

**Parameters:**

| | | |
|---|---|---|
| <count> | Range: | 1 to 8192 |
| | *RST: | 1 |

**TRIGger:DELay** <delay>

Sets the delay between the trigger event and the beginning of the actual measurement (integration).

**Parameters:**

| | | |
|---|---|---|
| <delay> | Range: | -5.0 s to 10.0 s |
| | *RST: | 0.0 s |
| | Default unit: | s |

**Manual operation:** See "Trigger Delay" on page 65

**TRIGger:DELay:AUTO** <state>

Activates the automatic setting of the delay time.

If activated, the measurement starts only after the R&S NRPM input is settled.

The function determines the delay value automatically. It is ignored if the set `TRIGger:DELay` time is longer than the automatically determined value.

**Parameters:**

| | | |
|---|---|---|
| <state> | *RST: | OFF |

**Manual operation:** See "Trigger Delay" on page 65

**TRIGger:DTIMe** <dropout_time>

Sets the dropout time for the internal trigger source. During this time, the signal power must exceed (negative trigger slope) or undercut (positive trigger slope) the level defined by the trigger level `TRIGger:LEVel` and and trigger hysteresis `TRIGger:HYSTeresis`.

At least, this time must elapse before triggering can occur again.

See "Dropout time" on page 117

**Parameters:**

<dropout_time> Range: 0.00 s to 10.00 s
*RST: 0.00 s
Default unit: s

**Manual operation:** See "Dropout" on page 65

---

**TRIGger:EXTernal<2...2>:IMPedance** <impedance>

Sets the termination resistance of the second external trigger input (`EXTernal2`). You can select between `HIGH`(~ 10 kOhm) and `LOW` (50 Ohms) to fit the impedance of the trigger source and thus minimize reflections on the trigger signals.

**Suffix:**

<2...2> 1..n

**Parameters:**

<impedance> HIGH | LOW
*RST: HIGH

---

**TRIGger:HOLDoff** <holdoff>

Sets the hold off time, see "Hold-off time" on page 118.

**Parameters:**

<holdoff> Range: 0.00 s to 10.00 s
*RST: 0.00 s
Default unit: s

**Manual operation:** See "Holdoff" on page 65

---

**TRIGger:HYSTeresis** <hysteresis>

Sets the hysteresis thresholds. A trigger event occurs, if the trigger level:

- Falls below the set value on a rising slope.
- Rises above the set value on a falling slope.

You can use the hysteresis to eliminate the effects of noise in the signal on the edge detector of the trigger system.

**Parameters:**

<hysteresis> Range: 0.00 dB to 10.00 dB
*RST: 0.00 dB
Default unit: dB

**Manual operation:** See "Hysteresis" on page 65

**TRIGger:IMMediate**

Triggers a generic trigger event that causes the sensor module to exit the WAIT_FOR_TRIGGER state immediately, irrespective of the trigger source and the trigger delay and start the measurement. The command is the only means of starting a measurement when the trigger source is set to HOLD. Only one measurement cycle is executed irrespective of the averaging factor.

**Usage:** Event

**TRIGger:LEVel** <level>

Sets the trigger threshold for internal triggering derived from the test signal.

This setting is effective only for the internal `TRIGger:SOURce`.

**Parameters:**

<level> Range: 1.0e-7 W to 200.0e-3 W
*RST: 1.0e-3 W
Default unit: W

**Manual operation:** See "Trigger Level" on page 65

**TRIGger:LEVel:UNIT** <unit>

Sets the unit of the trigger level if this value is entered without a unit.

See `TRIGger:LEVel`.

**Parameters:**

<unit> DBM | W | DBUV
*RST: W

**Example:** `TRIGger:LEVel:UNIT W`

**Manual operation:** See "Trigger Level" on page 65

**TRIGger:SENDer:PORT** <sender_port>

Selects the port where the R&S NRPM provides its internal trigger signal at the output, provided it is trigger sender (see `TRIGger:SENDer:STATe`).

You can assign either the port `EXTernal[1]` or `EXTernal2` for the trigger sender. If you want to trigger the sender sensor module externally with its own trigger signal, assign the trigger source to the other port accordingly, e.g:

```
TRIGger:SENDer:PORT    EXT1
TRIGger:SOURce         EXT2
TRIGger:SENDer:STATe   ON
```

or

```
TRIGger:SENDer:PORT    EXT2
TRIGger:SOURce         EXT1
TRIGger:SENDer:STATe   ON
```

**Parameters:**

| | | |
|---|---|---|
| <sender_port> | EXT1 \| EXTernal1 \| EXT2 \| EXTernal2 | |
| | *RST: | EXT1 |

**TRIGger:SENDer:STATe** <state>

Activates the trigger sender mode of the sensor module. In this state, the sensor module can output a digital trigger signal in synchronization with its own trigger event.

If activated, select the output port the trigger signal using `TRIGger:SENDer:PORT`.

Typically, the trigger sender uses its internal trigger source. But you can also trigger the trigger sender externally, since the R&S NRPM provides two external trigger connectors. If you trigger the sender externally, use `EXTernal1` as external trigger input port (trigger source) and `EXTernal2` as trigger sender output port or vice versa.

**Parameters:**

| | | |
|---|---|---|
| <state> | *RST: | OFF |

**TRIGger:SLOPe** <slope>

Available only if `TRIGger:SOURce INTernal/EXTernal`.

Determines what is used for triggering, depending on the trigger source:

- `TRIGger:SOURce INTernal`: uses the rising or falling edge of the envelope power.
- `TRIGger:SOURce EXTernal`: uses the increasing voltage.

**Parameters:**

| | | |
|---|---|---|
| <slope> | POSitive \| NEGative | |
| | *RST: | POSitive |

**Manual operation:** See "<Slope>" on page 64

**TRIGger:SOURce** <source>

Selects the source for the trigger event detector.

See Section 10.5.1, "Triggering", on page 116.

**Parameters:**

<source> HOLD | IMMediate | INTernal | INT1 | INT2 | INT3 | INTernal1 | INTernal2 | INTernal3 | BUS | EXTernal | EXT1 | EXTernal1 | EXT2 | EXT3 | EXTernal2 | EXTernal3 | BURSt1 | BURS1 | BURSt2 | BURS2 | BURSt3 | BURS3

**BUS**
Triggers the measurement with the commands `*TRG` or `TRIGger:IMMediate`, where `TRIGger:IMMediate` shortens the measurement. In this case, the other trigger settings are meaningless.

**EXTernal**
Initiates the measurement by the hardware trigger bus, e.g of the base unit. Waiting for a trigger event can be skipped by `TRIGger:IMMediate`.
`EXT`, `EXT1`, `EXTernal` and `EXTernal1` denote the same, an external trigger is applied through the round 8 pin connector.
`EXT2` and `EXTernal2` refer to external triggering initiated by the dedicated SMB type connector, TRIG2 I/O, at the rear of the sensor module.

**HOLD**
Triggers the measurement with the command `TRIGger:IMMediate`.

**IMMediate**
Starts the measurement immediately.

**INTernal | INT1 | INT2 | INT3**
Determines to consider the RF signal level at the specified antenna (1, 2 or 3) for launching a measurement. The parameter `INTernal` is a synonym for `INT1 | INTernal1`.
The measurement starts when the signal exceeds (`TRIGger:SLOPe POSitive`) or drops below (`TRIGger:SLOPe NEGative`) the power set with `TRIGger:LEVel`, after the `TRIGger:DELay` has elapsed. Similar to trigger source `EXT`, waiting for a trigger event can also be skipped by `TRIGger:IMMediate`.

*RST: IMMediate

**Manual operation:** See "<Source>" on page 64

---

**TRIGger:SYNC:PORT** <sync_port>

Selects the external connection for the sensor module's sync output, see also `TRIGger:SYNC:STATe`.

**Parameters:**
<sync_port> EXT1 | EXTernal1 | EXT2 | EXTernal2

*RST: EXT1

---

**TRIGger:SYNC:STATe** <state>

Usually used in combination with `TRIGger:SENDer:STATe ON`.

If activated, blocks the external trigger bus as long as the sensor modules remains in the measurement state.

This function makes sure, that a new measurement only starts after all sensor modules have completed their last measurement.

Make sure that the number of repetitions is the same for all the sensor modules involved in the measurement. Otherwise, the trigger bus is blocked by any sensor module that has completed its measurements before other sensor module and has returned to the IDLE state.

**Parameters:**
<state> *RST: OFF

## 10.11 Using the status register

Further information:

- Section 9.2, "Status reporting system", on page 79

Contents:



### 10.11.1 General status register commands

Remote commands:



---

**STATus:PRESet**

Resets the edge detectors and `ENABle` parts of all registers to a defined value.

**Usage:** Event

---

**STATus:QUEue[:NEXT]?**

Queries the most recent error queue entry and deletes it.

Positive error numbers indicate sensor module specific errors. Negative error numbers are error messages defined by SCPI.

If the error queue is empty, the querry returns 0 ("No error").

**Usage:** Query only

### 10.11.2 Reading out the CONDition part

For more information on the CONDition part see Section 9.2.2, "Structure of an SCPI status register", on page 81.

**STATus:DEVice:CONDition?**
**STATus:OPERation:CALibrating:CONDition?**
**STATus:OPERation:CONDition?**
**STATus:OPERation:LLFail:CONDition?**
**STATus:OPERation:MEASuring:CONDition?**
**STATus:OPERation:SENSe:CONDition?**
**STATus:OPERation:TRIGger:CONDition?**
**STATus:OPERation:ULFail:CONDition?**
**STATus:QUEStionable:CALibration:CONDition?**
**STATus:QUEStionable:CONDition?**
**STATus:QUEStionable:POWer:CONDition?**

These commands read out the `CONDition` section of the status register.

The commands do not delete the contents of the `CONDition` section.

**Usage:** Query only

### 10.11.3 Reading out the EVENt part

For more information on the EVENt part see Section 9.2.2, "Structure of an SCPI status register", on page 81.

**STATus:DEVice[:EVENt]?**
**STATus:OPERation:CALibrating[:SUMMary][:EVENt]?**
**STATus:OPERation[:EVENt]?**
**STATus:OPERation:LLFail[:SUMMary][:EVENt]?**
**STATus:OPERation:MEASuring[:SUMMary][:EVENt]?**
**STATus:OPERation:SENSe[:SUMMary][:EVENt]?**
**STATus:OPERation:TRIGger[:SUMMary][:EVENt]?**
**STATus:OPERation:ULFail[:SUMMary][:EVENt]?**
**STATus:QUEStionable[:EVENt]?**
**STATus:QUEStionable:CALibration[:SUMMary][:EVENt]?**
**STATus:QUEStionable:POWer[:SUMMary][:EVENt]?**

These commands read out the `EVENt` section of the status register.

At the same time, the commands delete the contents of the `EVENt` section.

**Usage:** Query only

### 10.11.4 Controlling the ENABle part

For more information on the ENABLe part see Section 9.2.2, "Structure of an SCPI status register", on page 81.

**STATus:DEVice:ENABle** <value>
**STATus:OPERation:CALibrating:ENABle** <value>
**STATus:OPERation:ENABle** <value>
**STATus:OPERation:LLFail:ENABle** <value>
**STATus:OPERation:MEASuring:ENABle** <value>
**STATus:OPERation:SENSe:ENABle** <value>
**STATus:OPERation:TRIGger:ENABle** <value>
**STATus:OPERation:ULFail:ENABle** <value>
**STATus:QUEStionable:CALibration:ENABle** <value>
**STATus:QUEStionable:ENABle** <value>
**STATus:QUEStionable:POWer:ENABle** <value>

These commands control the `ENABle` part of a register.

The `ENABle` part allows true conditions in the `EVENt` part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

**Parameters:**

| | | |
|---|---|---|
| <value> | *RST: | 0 |

## 10.11.5 Controlling the negative transition part

For more information on the negative transition part see Section 9.2.2, "Structure of an SCPI status register", on page 81.

**STATus:DEVice:NTRansition** <value>
**STATus:OPERation:CALibrating:NTRansition** <value>
**STATus:OPERation:NTRansition** <value>
**STATus:OPERation:LLFail:NTRansition** <value>
**STATus:OPERation:MEASuring:NTRansition** <value>
**STATus:OPERation:SENSe:NTRansition** <value>
**STATus:OPERation:TRIGger:NTRansition** <value>
**STATus:OPERation:ULFail:NTRansition** <value>
**STATus:QUEStionable:CALibration:NTRansition** <value>
**STATus:QUEStionable:NTRansition** <value>
**STATus:QUEStionable:POWer:NTRansition** <value>

These commands control the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

**Parameters:**

| | | |
|---|---|---|
| <value> | *RST: | 0 |

### 10.11.6 Controlling the positive transition part

For more information on the positive transition part see Section 9.2.2, "Structure of an SCPI status register", on page 81.

**STATus:DEVice:PTRansition** <value>
**STATus:OPERation:CALibrating:PTRansition** <value>
**STATus:OPERation:PTRansition** <value>
**STATus:OPERation:LLFail:PTRansition** <value>
**STATus:OPERation:MEASuring:PTRansition** <value>
**STATus:OPERation:SENSe:PTRansition** <value>
**STATus:OPERation:TRIGger:PTRansition** <value>
**STATus:OPERation:ULFail:PTRansition** <value>
**STATus:QUEStionable:CALibration:PTRansition** <value>
**STATus:QUEStionable:PTRansition** <value>
**STATus:QUEStionable:POWer:PTRansition** <value>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

**Parameters:**
<value> *RST: 65535

## 10.12 Testing the R&S NRPM OTA Power Measurement Solution

The selftest allows a test of the internal circuitry of the sensor.



**TEST:SENSor?** [<Item>]

Triggers a selftest of the sensor module. In contrast to `*TST?`, this command returns detailed information that you can use for troubleshooting.

**Note:** Do not apply a signal while the selftest is running because it can indicate errors in the output messages for the test steps *Offset Voltages* and/or *Noise Voltages*.

**Query parameters:**
<Item> String

**Usage:** Query only

**Manual operation:** See "Selftest" on page 67

## 10.13 Calibrating/zeroing the R&S NRPM3(N) sensor module

Zeroing removes offset voltages from the analog circuitry of the sensor modules, so that there are only low powers displayed when there is no power applied. The zeroing process may take more than 8 seconds to complete.

We recommend that you zero in regular intrervals (at least once a day), if :

- The temperature has varied by more than 5 K.
- The sensor module has been replaced.
- No zeroing was performed in the last 24 hours.
- Signals of very low power are to be measured, for instance, if the expected measured value is less than 10 dB above the lower measurement range limit.

Turn off all test signals before zeroing. An active test signal during zeroing causes an error.

Remote commands:



**CALibration<1...4>:DATA** <caldata>

Writes a binary calibration data set in the memory of the sensor module.

**Suffix:**
<1...4> 1..n

**Parameters:**
<caldata> <block_data>

**CALibration<1...4>:DATA:LENGth?**

Queries the length in bytes of the calibration data set currently stored in the flash memory. Programs that read out the calibration data set can use this information to determine the capacity of the buffer memory required.

**Suffix:**
<1...4> 1..n

**Usage:** Query only

**CALibration<Channel>:ZERO:AUTO** <state>

Performs zeroing using the signal at the sensor module input.

Disconnect the sensor module from all power sources, since any signal at the RF input of the sensor module affects the calibration.

While zero calibration is in progress, no queries or other setting commands are allowed. Any communication attempt can run into a timeout.

The setting command accepts only the parameter `ONCE`; `OFF` and `ON` are ignored.

The query returns the value `ON` if a calibration is in progress, otherwise the value `OFF`.

**Suffix:**
<Channel> 1...4
The channel suffix is ignored.

**Parameters:**
<state> *RST: OFF

**Manual operation:** See "Zero Calibration" on page 62

# 11 Programming examples

This section provides programming examples for R&S NRPM OTA power measurement tasks. It includes examples for continuous average and trace power measurements in the common SCPI syntax.

In addition, Rohde & Schwarz provides archives with source code, project and auxiliary files, and programming examples under C/C++ and Python. The samples can be integrated into customer-specific applications.

The programming examples are part of the R&S NRP-Toolkit, see Section 4.6.2, "R&S NRP-Toolkit", on page 20.

## 11.1 Performing a simple measurement

The simplest way to obtain a result is to use the following sequence of SCPI commands:

**Example:**

```
*RST        // sets the continuous average mode and all parameters to default
INITiate    // initiates the measurement
FETCh?      // delivers measurement result to the output queue
```

When the measurement is complete, you can retrieve the result from the output queue.

## 11.2 Performing measurements in continuous average mode

This section describes programming examples for measuring continuous average power with one R&S NRPM. The examples demonstrate the sequences in SCPI syntax, pseudo code, and also show the corresponding source codes for using VISA protocol.

### Example: SCPI sequence for measuring the power of three antenna modules

The command sequence measures the continuous average power of the three channels of an R&S NRPM.

```
// Query the resource identifier and reset the sensor module to default
*IDN?
// Response: ROHDE&SCHWARZ,NRPM3,100001,16.09.20.01
*RST
// Enable all channels of the sensor module
SENSe:CHAnnel1:ENABle 1
SENSe:CHAnnel2:ENABle 1
SENSe:CHAnnel3:ENABle 1
// Select measurement mode and set the time interval to 10 µs
SENSe:FUNCtion "POWer:AVG"
SENSe:POWer:AVG:APERture 10e-6
//Set the averaging filter length to 1
SENSe:AVERage:COUNt 1
// Select the trigger source
TRIGger:SOURce IMMediate
// Activate a measurement
INITiate:IMMediate
// Query the measurement results
FETCh:ALL?
// Response:
// 6.118910E-10,1.185138E-10,4.612524E-10
// Read out all errors / Clear error queue
SYSTem:ERRor?
SYSTem:SERRor?
```

### Example: Pseudo code for measuring the power of two antenna modules

This example, written in pseudo code, shows a reduced set of basic steps to set up and execute a continuous average measurement.

```
// resource = "NRPM3-100001"
// Open the device
sensor = Open( resource )
// Query the resource identifier and reset the sensor module to default
Query( sensor, "*IDN?" )
Write( sensor, "*RST" )
// Measure only on channels 1 & 3
Write( sensor, "SENS:CHAN1:ENAB ON" )
Write( sensor, "SENS:CHAN2:ENAB OFF" )
Write( sensor, "SENS:CHAN3:ENAB ON" )
Write( sensor, "SENS:FUNC \"POW:AVG\"" )
Write( sensor, "TRIG:SOUR IMM" )
Query( sensor, "SYST:ERR?" )
Query( sensor, "SYST:SERR?" )
Write( sensor, "INIT:IMM" )
Query( sensor, "FETCH:ALL?" )
Close( sensor )
```

**Example: C/C++ (VISA) source code**

This sequence shows the VISA source code, based on the *pseudo code* example above.

```
// Determine the resource identifier, e.g.
// resource = "NRPM3-100001"
// resource identifier = USB0::0x0aad::0x0195::100001
// Open the device
viOpen( defaultRM, “USB0::0x0aad::0x0195::100001”, VI_NULL, VI_NULL,&session );
// Select the measurement mode
viWrite( session, “SENS:FUNC \”POW:AVG\”\n”, 20, &uiSent );
// Initiate a single measurement
viWrite( session, “INIT:IMM\n”, 9, &uiSent );
// Read the measurement result
viWrite( session, “FETCH:ALL?\n”, 7, &uiSent );
viRead( session, buffer, sizeof(buffer), &uiCnt );
// buffer = “1.468872E-09,3.682521E-10,3.829144E-09”
// Close the device
viClose( session );
```

**Example: Python (VISA) source code**

This sequence shows the Python source code, based on the *pseudo code* example above.

```
####################################################################
## Name:        contAv-M3.py
## Purpose:     Measuring RF power with the R&S NRPM3 OTA sensor module
## Description: This example demonstrates the use of an R&S NRPM3
##              sensor module measuring continuously average power
##              on up to 3 channels
## Author:      Juergen D. Geltinger
## Created:     2016-01-14
## Modified by: Juergen D. Geltinger
## Modified:    2016-07-21
## Copyright:   (c) Rohde & Schwarz, Munich
####################################################################

# This is a Visa sample, so import that module
import visa
from time import sleep
from math import fabs, log10

####################################################################
# Find a R&S NRPM3 power sensor modules. That sensor module is
# characterized by a Product ID of 0x0195
####################################################################
def OpenFirstNRPM3():
   rm = visa.ResourceManager()
   resources=list(rm.list_resources())
   for s in resources:
      # NRPM3 RF sensor module has a USB Product ID of '0x0195'
      if -1 != s.find("0195::"):
         print
         print "Opening NRPM3 sensor '" + s + "'..."
         sensor = rm.open_resource( s )
         if sensor != None:
            sensor.timeout = 20000
            # Setting Aperture Time
            sensor.write( "sens:pow:avg:aper 10e-6" )
            # Setting Average Filter Length
            sensor.write( "sens:aver:count 16" )
            print "Querying *IDN?..."
            print sensor.ask( "*idn?" )
            # Enable the available/connected antenna modules
            result = ""
            for antenna in range(3):
               cmd = "SENS:CHAN{}:PRES?".format( antenna + 1 )
               res = sensor.ask(cmd)
               if int(res) == 1:
                  cmd = "SENS:CHAN{}:ENAB ON".format( antenna + 1 )
```

```
               else:
                  cmd = "SENS:CHAN{}:ENAB OFF".format( antenna + 1 )
               sensor.write(cmd)
            print "SYST:ERR?  --> " + sensor.ask("SYST:ERR?")
            print "SYST:SERR? --> " + sensor.ask("SYST:SERR?")
            return sensor
            break
   return None

####################################################################
# Convert a power value of Watt unit to dBm unit
####################################################################
def Watt2dBm( dW ):
   if fabs( dW ) < 1.0e-19:
      return -160.0
   return 10.0 * log10( fabs( dW ) ) + 30.0

####################################################################
####################################################################
####################################################################
sensor = None
sensor = OpenFirstNRPM3()
if sensor != None:
   for meas in range(1,10):
      sensor.write("init:imm")
      result = sensor.ask("fetch:all?")
      antenna = [float(x) for x in result.split(",")]
      if antenna[0] < 9.9e37:
         print ('Antenna A = %4.1f dBm' % Watt2dBm( antenna[0] ) )
      if antenna[1] < 9.9e37:
         print ('Antenna B = %4.1f dBm' % Watt2dBm( antenna[1] ) )
      if antenna[2] < 9.9e37:
         print ('Antenna C = %4.1f dBm' % Watt2dBm( antenna[2] ) )
      print
   sensor.close()
else:
   print "No NRPM3 sensor found"
```

## 11.3 Performing measurements in list mode

This section briefly introduces the list mode operation, and describes a programming example for measuring average power sequentially at predefined RF frequency points with the R&S NRPM OTA Power Measurement Solution in list mode. The example represents the execution of a R&S NRPM OTA power sensor measurement under VISA environment in pseudo code.

### About list mode

The list mode enables you, to define a series of measurements at different frequency points in advance. The factors and values, that must be recalculated for each frequency point, are determined and saved internally before the measurement starts. Both, the R&S NRPM3(N) sensor module, and the DUT get the list of frequency points, and the R&S NRPM3(N) pre-calculates the corresponding parameters required for the measurement.

Synchronized by an initial RF pulse and a short delay time, the DUT and the R&S NRPM OTA power sensor measurement system perform the measurement for each frequency point automatically. They switch to the next frequency point controlled by a defined time interval.

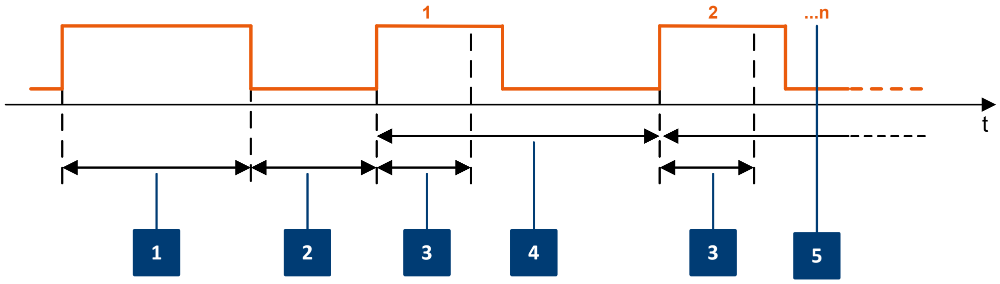



*Figure 11-1: Time scheme in list mode processing*

1 = Start burst
2 = Initial delay
3 = Single measurement time X
4 = Measurement period
5 = Frequency points n

### Related list mode parameters

- **Start burst** = RF pulse of at least 10 µs minimum length, sent by the DUT
- **Initial delay** = time after the start burst until the measurement starts
- **Measurement period** = time from the beginning until the end of a step at one frequency point
- **n** = number of frequency points in the list
- **X** = actual time for a single measurement, calculated according to the formula:
  X = 2 * AverageCount * (ApertureTime + 100µs)
- **AverageCount** = number of averaged measurement readings
- **ApertureTime** = width of the sampling window

**Aspects to consider**

- Minimum measurement time **220µs**
  The time span of the measurement pulse must not be below the minimum value, derived from:
  AverageCount (min) = 1, ApertureTime (min) = 10 µs:
  X = 2 * 1 * (10 µs+100 µs) = 220 µs
  Shorter pulses cannot be measured.
- The total number of pulses is summed up of the number of frequency points and the start burst.

**Example: Pseudo code for measuring the power in list mode**

This example, written in pseudo code, shows how to set up and execute a power measurement in list mode.

```
===================================
 Description of Receiver List Mode
===================================

The execution of a configured frequency list shall start with an RF pulse
sent by the DUT with a certain minimal length (= calling this 'start burst').

     _________________..._________________
     |                                    |
     |<--- min. length of start burst --->|
_____|                                    |_______...


After the FALLING edge of the start burst, the sensor will apply a
configurable initial delay and then cycles over the configured frequency list,
doing power measurements with pre-configured aperture windows and average
counts. Each new measurement starts after a selectable measurement period.

   _________________                    ____________            ____________
   |               | <-initial delay-> |        |   |          |        |   |
   | -start burst- |                   |<- X ->|   |          |<- X ->|   |
___|  (see above)  |_______...__________|        |___...____|        |__...

                                        <-measurement period->

'X' is the time for a single measurement. It is calculated as follows:

 X = 2 * Average-Count * (ApertureTime + 100us)

*/

  ViSession    session;
  string       strCmd;
  string       strRead;
  unsigned int uiAvgCount              = 2;         //  2
  double       dAperture               = 100.0e-6;  //  100 us
  double       dTriggerLevel           = 100.0e-9;  //  100 nW (= -40 dBm)
  int          iTriggerAntenna         = 1;         //  Trigger-Burst re-
                                                    //  cognition on Ant 1
  double       dMinLengthOfStartBurst  = 950.0e-6;  //  950 us
  double       dInitialDelayAfterBurst = 1.0e-3;    //  1 ms
  double       dMeasurementPeriod      = 2.0e-3;    //  2 ms
  double       arFreqList[]            = { 24.0e9, 24.5e9, 25.0e9,
                                           25.5e9, 26.0e9, 26.5e9,
                                           27.0e9, 27.5e9, 28.0e9 };
```

```
session = OpenfirstNRPM3onUSBorNetwork();

//==================================================================
// *RST and *IDN?
WriteCmd(session, "*RST");
printf( Query(session, "*IDN?");


//==================================================================
// Use only those antennas which are physically connected
for (size_t nAntenna = 0; nAntenna < 3; nAntenna++)
{
  strCmd = "SENS:CHAN" + str(1+nAntenna) + ":PRES?";
  strRead = Query(session, strCmd);
  if ( atoi(strRead) != 0 )
    strCmd = "SENS:CHAN" + str(1+nAntenna) + ":ENAB ON";
  else
    strCmd = "SENS:CHAN" + str(1+nAntenna) + ":ENAB OFF";

  WriteCmd(session, szCmd);
}


//==================================================================
// Prepare Event Registers to recognize a finished measurement
//
// We want to detect the End of a Measurement;
//   This is reflected by a negative transition of the
//   'Sensor Measuring' bit (bit value = 2)
WriteCmd(session, "STAT:OPER:MEAS:PTR  0");
WriteCmd(session, "STAT:OPER:MEAS:NTR  2");
WriteCmd(session, "STAT:OPER:MEAS:ENAB 2");

// We want to detect the MEAS summary bit (as a
//   results of the finished measurement as defined
//   above). This is reflected by a positive transition
//   'MEAS summary' bit in the Operation Status Register
//   (bit value = 16)
WriteCmd(session, "STAT:OPER:PTR  16");
WriteCmd(session, "STAT:OPER:NTR   0");
WriteCmd(session, "STAT:OPER:ENAB 16");


//==================================================================
// Setup the Measurement...
//
// Configure Averaging
strCmd = "SENS:AVER:COUNT " + str(uiAvgCount);
```

```
WriteCmd(session, strCmd);
WriteCmd(session, "SENS:AVER:STAT ON");

// Aperture time
strCmd = "SENS:POW:AVG:APER " + str(dAperture);
WriteCmd(session, strCmd);


// Prepare the triggering of the measurement start
// (= start of execution of the configured freq. list)
//
// The execution of the configured frequency list shall
// start with an RF pulse from the DUT with a certain
// minimal length (here 950 us). The sensor setting
// 'trigger dropout' time is used to recognize this,
// and the execution shall start after the FALLING edge
// of this initial 'start burst':
//       _________________..._________________
//       |                                    |
//       |<--- min. length of start burst --->|
//  _____|                                    |_______...
//
//
// Trigger on falling edge (= neg. slope)
WriteCmd(session, "TRIG:SLOP NEG");

// Minimal length of start burst (= Trigger Dropout)
strCmd = "TRIG:DTIM " + str(dMinLengthOfStartBurst);
WriteCmd(session, strCmd);

// Trigger on the signal level on a selected antenna
strCmd = "TRIG:SOUR BURST " + str(iTriggerAntenna);
WriteCmd(session, strCmd);

// Trigger Level
strCmd = "TRIG:LEV " + str(dTriggerLevel);
WriteCmd(session, strCmd);


// After the initial start pulse a continuous sequence of
// measurements are executed. The number of measurements is
// selected by the length of the frequency list -- see entries
// in 'arFreqList[]' above (here 9)
//
// There very first measurement starts after a short initial delay
// (= 'trigger burst delay') to give the DUT time to setup/prepare
// its sending of the planned frequencies
//     _________________                   __________         __________
//     |                | <-initial delay-> |      |  |        |      |  |
//     | -start burst-  |                   |<-X->|  |        |<-X->|  |
```

```
// __|  (see above)  |________..._________|        |___...__|        |__...
//
//                                         <- meas. period ->
//                                         (= trigger holdoff)
//
// 'X' is the Time for a single measurement. 'X' shall be shorter than
//     the receiving pulse from the DUT.
//
// X = 2 * Average-Count * (ApertureTime + 100us)
//


// Initial delay before the very first measurement
// (= 'trigger burst delay')
strCmd = "TRIG:BURS:DEL " + str(dInitialDelayAfterBurst);
WriteCmd(session, strCmd);

// The measurement period is timed by the 'trigger holdoff' parameter
// This is simply the distance from one measurement start to the next
strCmd = "TRIG:HOLD " + str(dMeasurementPeriod);
WriteCmd(session, strCmd);

// Freq List
strCmd = "SENS:LIST:FREQ ";
strCmd += ConvertListToString(arFreqList, 9);
WriteCmd(session, strCmd);

WriteCmd(session, "CONT:FREQ:MODE RXLIST");

// Desired Result Data Format (here ASCII)
WriteCmd(session, "FORM:DATA ASC");


// Check for any setting errors
print(Query(session, "SYST:ERR?");

// Check for static errors
print(Query(session, "SYST:SERR?");

//===================================================================
// Execute the list mode measurement
//
// resetting the event information by an initial readout
Query(session, "STAT:OPER:MEAS:EVEN?");
Query(session, "STAT:OPER:EVEN?");

// Start a measurement
WriteCmd(session, "INIT:IMM");

// Synchronize with end of measurement...
```

```
// (We will prematurely end this function if we do not get a trigger
//  within approx. 30 seconds)
bool bMeasReady = FALSE;
unsigned int uiSleep = 10;  // 10 ms
unsigned int uiWaitForTriggerTimeoutCount = 5000 / uiSleep;
unsigned short usEvent = 0;
while (!bMeasReady)
{
  Query(pSensor->session, "STAT:OPER:MEAS:EVEN?", szReadBuff,
        sizeof(szReadBuff));
  usEvent = atoi(Query(session, "STAT:OPER:MEAS:EVEN?"));
  bMeasReady = ((usEvent & 0x02) != 0);
  if (bMeasReady)
    break;

  if (uiWaitForTriggerTimeoutCount > 0)
  {
    --uiWaitForTriggerTimeoutCount;
    _sleep(10);
  }
  else
    break;
}

// If no trigger burst has been recognized, we prematurely end here!
if (!bMeasReady)
  return 0;  // No results


// Fetch AVERAGE results
WriteCmd(session, "CALC:FEED \"POW:AVER\"");
strRead = Query(session, "FETCH:ALL?");

print( strRead );   // all measurement results

close(session);
```

## 11.4 Performing measurements in trace mode

This section describes programming examples for measuring power over time with the R&S NRPM OTA Power Measurement Solution. The examples demonstrate the sequences in SCPI syntax, pseudo code, and also show the source codes for using VISA protocol.

**Example: SCPI sequence for measuring the power of three antenna modules**

The command sequence measures the envelope power over time in the three channels of the R&S NRPM antenna module.

```
// Query the resource identifier and
// reset the sensor module to default
*IDN?
// Response: ROHDE&SCHWARZ,NRPM3,100001,16.09.20.01
*RST
// Enable all channels of the sensor module
SENSe:CHAnnel1:ENABle 1
SENSe:CHAnnel2:ENABle 1
SENSe:CHAnnel3:ENABle 1
// Set the trace measurement mode
SENSe:FUNCtion "XTIME:POWer"
// Set the trace time.It influences the time length of a point
// since each point represents the time period resulting from
// the trace time divided by the number of points
SENSe:TRACe:TIMe 10e-3
// Set the number of points for the trace measurement
// Using 500 points usually represents a good compromise
// between USB transfer speed and resolution
SENSe:TRACe:POINTs 10
// Enable and configure the averaging filter
SENSe:TRACe:AVERage:COUNt 8
SENSe:TRACe:AVERage:STATe ON
// Configure the trigger
TRIGger:SOURce INTernal
TRIGger:SLOPe POSitive
TRIGger:DTIMe 0.001
TRIGger:HYSTeresis 0.1
TRIGger:LEVel 100e-9
// Activate the measurement
INITiate
// Query the measurement results
FETCh:ALL?
// Response (10 points per channel):
// 1.247340E-07,9.701300E-11,1.249202E-07,1.255408E-10,1.248314E-07,
// 9.718711E-11,1.248812E-07,6.739847E-11,1.248604E-07,2.118106E-10,
// 1.644239E-09,4.748356E-11,1.676801E-09,6.181332E-12,1.670082E-09,
// -1.933849E-11,1.719137E-09,-4.777736E-12,1.678197E-09,3.814278E-12,
// -4.753650E-11,-7.962022E-12,-4.782197E-11,-3.001128E-11,-8.387346E-12,
// -5.910127E-11,5.714555E-11,-5.767460E-12,7.732340E-11,-1.816896E-11
// Read out all errors / Clear error queue
SYSTem:ERRor?
SYSTem:SERRor?
// Stop the continuous measurement.
INITiate:CONTinuous OFF
```

**Example: Pseudo code for measuring the power of two antenna modules**

This example, written in pseudo code, shows how to set up and execute a trace power measurement.

```
// resource = "NRPM3-100001"
// Open the device
sensor = Open( resource )
// Query the resource identifier and reset the sensor module to default
Query( sensor, "*IDN?" )
Write( sensor, "*RST" )
// Measure only on channels 1 & 3
Write( sensor, "SENS:CHAN1:ENAB ON" )
Write( sensor, "SENS:CHAN2:ENAB OFF" )
Write( sensor, "SENS:CHAN3:ENAB ON" )
Write( sensor, "SENS:FUNC \"XTIM:POW\"" )
Write( sensor, "TRIG:SOUR IMM" )
Query( sensor, "SYST:ERR?" )
Query( sensor, "SYST:SERR?" )
Write( sensor, "INIT:IMM" )
Query( sensor, "FETCH:ALL?" )
Close( sensor )
```

**Example: C/C++ (VISA) source code**

This sequence shows the VISA source code, based on the *pseudo code* example above.

```
// Determine the resource identifier, e.g.
// resource = "NRPM3-100001"
// resource identifier = USB0::0x0aad::0x0195::100001
// Open the device
viOpen( defaultRM, “USB0::0x0aad::0x0195::100001”, VI_NULL, VI_NULL,&session );
// Select the trace measurement mode
viWrite( session, “SENS:FUNC \”XTIM:POW\”\n”, 21, &uiSent );
// Set the overall length (10 ms) of the trace
// select the number of measurment points (500 points)
viWrite( session, “SENS:TRAC:TIME 10.0e-3\n”, 23, &uiSent );
viWrite( session, “SENS:TRAC:POINTS 500\n”, 21, &uiSent );
// Initiate a single measurement
viWrite( session, “INIT:IMM\n”, 9, &uiSent );
// Read the measurement result
viWrite( session, “FETCH1?\n”, 7, &uiSent );
viRead( session, resA, sizeof(resA), &uiCnt );
viWrite( session, “FETCH2?\n”, 7, &uiSent );
viRead( session, resB, sizeof(resB), &uiCnt );
viWrite( session, “FETCH3?\n”, 7, &uiSent );
viRead( session, resC, sizeof(resC), &uiCnt );
// process resA, resB and resC. Every buffer contains
// the measurement data of one channel
// Close the device
viClose( session );
```

# 12 Troubleshooting



## 12.1 Displaying status information

Status information is available in several ways.

**Status LED of the R&S NRPM**

The position of the status LED is indicated in Section 5, "R&S NRPM tour", on page 24.

The meaning of the different colors and blinking frequencies is explained in "Status LED (2)" on page 25.

**Title bar of the web user interface (R&S NRPM3N LAN sensor module)**

Requires a sensor module with networking capabilities, a R&S NRPM3N sensor module.

The position of the status icon is indicated in Figure 7-1. The colors are explained in "Status LED (2)" on page 25.

## 12.2 Performing a selftest

The selftest gives you detailed information that you can use for troubleshooting.

Do not apply a signal to the sensor module while the selftest is running.
Executing the self-test with an active signal assigned, can erroneously result in error messages at the test steps *Offset Voltages* and/or *Noise Voltages*.

**To execute the selftest over remote control**

► For a quick check, send `TEST:SENSor?`.

For each test step, PASS or FAIL is listed.

**To execute the self test in the web user interface (R&S NRPM3N LAN sensor module)**

1. In the navigation pane of the main dialog, select "Sensor".
2. Under "Diagnostics", select "Selftest".
   See also "Selftest" on page 67.

## 12.3 Problems during a firmware update

The firmware update is described in Section 8, "Firmware update", on page 69.

Solutions for potential problems that can occur when using the firmware update, see "Firmware update" on page 70.

**Firmware update was interrupted**

If, for example, a power cut happened during the firmware update, problems can occur.

1. Perform the firmware update again. Sometimes, a further update fixes the problems.
2. If you nevertheless can not access the sensor module, contact the local service representative.

**Firmware update was aborted**

If there is not enough free memory space, the firmware update aborts. An error message is displayed, and the status LED of the sensor module starts flashing red.

1. Execute the sanitzation procedure, as described in the instrument security procedures. You find this document on the product page at: www.rohde-schwarz.com/manual/nrpm.
2. Start the firmware update again.

## 12.4 Cannot establish a LAN connection

If you have problems to establish a LAN connection as described in Section 6.3.4, "Using the LAN connection", on page 42, try the following measures:

- Use the *Configure Network Sensor* component of the R&S NRP-Toolkit, see "Components of the R&S NRP-Toolkit" on page 21.
- "Troubleshooting for peer-to-peer connections" on page 45.

# 12.5 Replacing antenna cables

## 12.5.1 Spare parts and recommended tools

The available cable replacement kits are listed in the table that follows:

| Description | Part no. | Applicable for A90 | Applicable for A90D |
|---|---|---|---|
| Cable replacement Kit, 550 mm | 1436.2855.02 | yes | yes |
| Cable replacement Kit, 750 mm | 1436.2855.03 | yes | yes |
| Cable replacement Kit, 1000 mm | 1436.2855.04 | yes | yes |
| Cable replacement Kit, 1500 mm | 1436.2855.05 | yes | yes |

The recommended tools are listed in the table that follows:

| Tool | Description, part no. |
|---|---|
| Screwdriver, flat tip<br>Blade width 3 mm max. | Commercial off the shelf<br>**Example:**<br>WERA Werk Hermann Werner GmbH & Co. KG<br>160 i VDE insulated screwdriver for slotted screws<br>Part no. 05006100001<br>www.wera.de |
| Cable tie tool<br>(Force: 50 N ± 5 N) | Commercial off the shelf<br>**Example:**<br>PANDUIT®<br>GS2B tension<br>Part no.: GSB2<br>www.panduit.com |
| Electronics side cutter | Commercial off the shelf<br>**Example:**<br>KNIPEX-Werk C. Gustav Putsch KG<br>Electronic Super Knips®<br>Part no. 78 71 125<br>www.knipex.com |

## 12.5.2 Cable replacement

- There are two versions of the strain relief.
  The old version is shown on the left hand side of the figures. The new version is shown on the right hand side of the figures.
- The procedure of cable replacement is shown for the single variant of the strain relief. The procedure is also applicable for the dual variant of the strain relief.

**To change the antenna cable**

1. Remove the cable tie.
   Use the electronics side cutter (part no. 78 71 125 or equivalent).

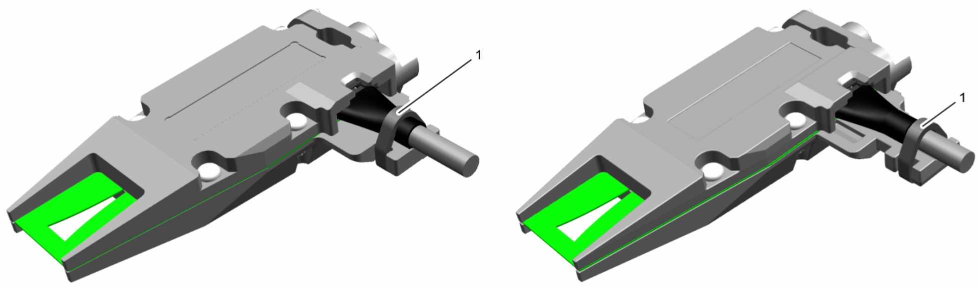



*Figure 12-1: Removing cable tie*

2. Hold the locking lug down to unlock the cable.
   Use the flat tip screwdriver (part no. 05006100001 or equivalent).

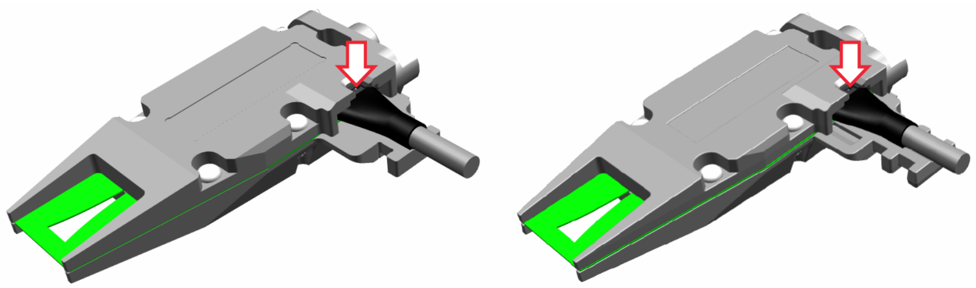


*Figure 12-2: Unlocking cable*

3. **NOTICE!** Remove the cable in a linear movement to prevent damage.
   While you hold down the locking lug, remove the cable.
4. Place the new cable in the notch.

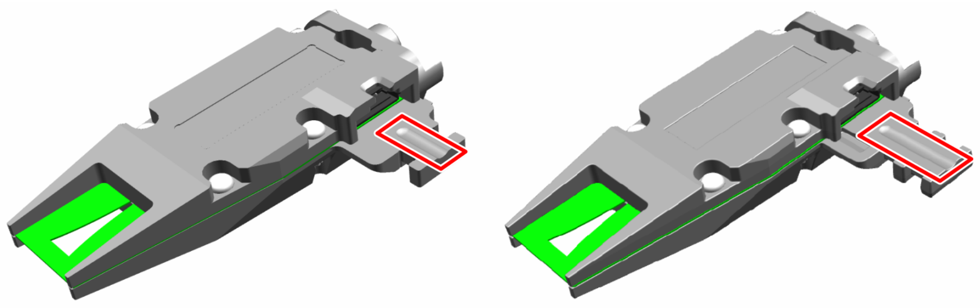


*Figure 12-3: Placing the new cable*

5. **NOTICE!** Connect the new cable in a linear movement to prevent damage.

   Connect the new cable until it snaps in.

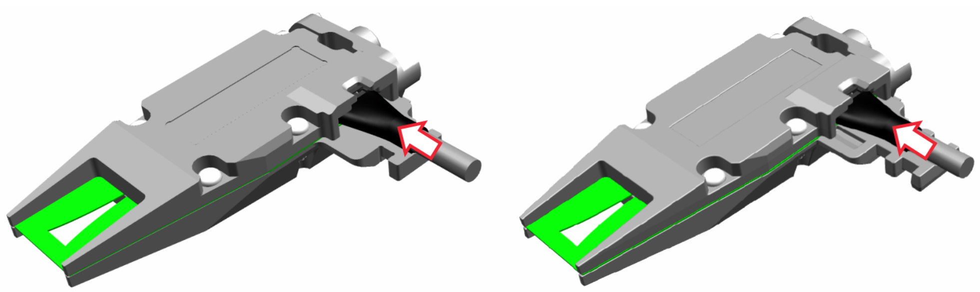


*Figure 12-4: Connect new cable*

6. **NOTICE!** Monitor the position of the cable tie head.

   Place the cable tie. Use the notch to place the cable tie correctly.

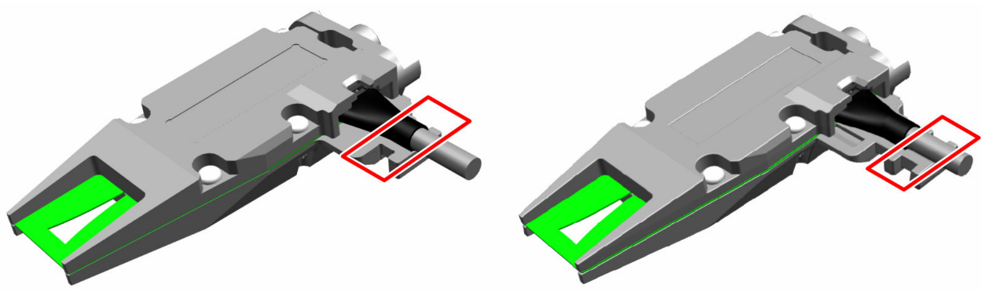


*Figure 12-5: Placing a cable tie*

7. **NOTICE!** Risk of damage of the cable and the connector. Make sure that the force of the automatic cable tie gun is set correctly to prevent cable damage. Make sure that the cable is free of load.

   Fasten the cable tie.
   Use the cable tie tool (part no. GSB2 or equivalent). Set the force of the cable tie tool to 50 N ±5 N.

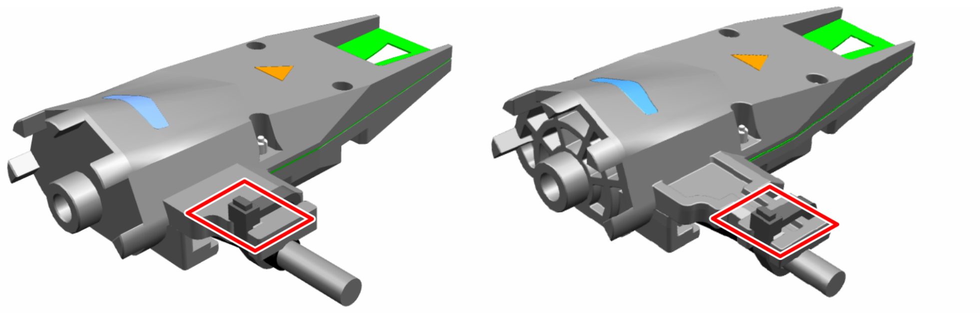


*Figure 12-6: Position of the cable tie head*

8. Cut off the protruding cable tie.
   Use the electronics side cutter (part no. 78 71 125 or equivalent).
9. **NOTICE!** We recommend that you execute a selftest after replacing the cables and reassembling the system.
   Execute a selftest with the command:
   `TEST:SENSor?` on page 156
10. Check the selftest for passed or failed, using the command:
    `TEST:SENSor??`

## 12.6 Contacting customer support

**Technical support – where and when you need it**

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

**Contact information**

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:

*Figure 12-7: QR code to the Rohde & Schwarz support page*

# 13 Transporting

### Packing

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection. You can also contact your local Rohde & Schwarz service center for advice.

### Securing

When moving the product in a vehicle or using transporting equipment, make sure that the product is properly secured. Only use items intended for securing objects.

### Transport altitude

The maximum transport altitude without pressure compensation is specified in the specifications document.

# 14 Maintenance, storage and disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable to check the nominal data from time to time.

## 14.1 Cleaning

**To clean the R&S NRPM3(N) sensor module**

1. Disconnect the sensor module from the antenna modules.
2. Disconnect the sensor module from the controller PC.
3. Clean the outside of the R&S NRPM3(N) sensor module using a lint-free cloth. You can dampen the cloth with water but keep in mind that the casing is not waterproof. If you use isopropyl alcohol or ethanol instead of water, be careful not to damage the labeling.
   Do not use cleaning agents that can damage the instrument such as solvents, acids or alkalis.
4. To dislodge any particels from the antenna interface connector, use clean compressed air.

**To clean the antenna modules**

► To dislodge any particels from the waveguide of an antenna module, use clean compressed air only.

  Do not use any liquids for cleaning.

## 14.2 Storage

Put plastic end caps on the RF connectors to protect them from damage. Protect the product against dust.

Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the specifications document.

Always store the antenna modules in the original package to avoid mechanical damage.

## 14.3 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

**Disposing of electrical and electronic equipment**

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

*Figure 14-1: Labeling in line with EU directive WEEE*

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

# Glossary: List of used terms and abbreviations

## A

**anechoic chamber:** Non-reflective, non-echoing box (RF shielded box) or chamber (RF test chamber) that absorbs reflections of radio frequencies, used to test antennas, radars or electromagnetic interference.

**API:** Application Programming Interface

**Average count:** Number of averaged readings

**Average factor:** see Average count

## B

**Beamforming:** Steering a beam in the direction of the receiver.

## C

**Computer name:** An unambiguous indication of the instrument in a LAN that uses a DNS server.
The default computer name follows the syntax `NRPM3-<serial number>`, e.g. *NRPM3-100099*.
Synonym: Hostname
See Serial number.

**CW:** Continuous Wave

## D

**DUT:** Device Under Test

## E

**EIRP:** Equivalent Isotropically Radiated Power

**Ethernet:** Linking technology to connect computers and electronic devices in wired local area networks (LANs).

## G

**Glossary:** List of the often used terms and abbreviations

**GUI:** Graphical User Interface

## H

**Hostname:** Computer name

## L

**LAN:** Local Area Network. A network that connects computers and electical devices within a small area.

## O

**OS:** Operating System

**OTA:** Over The Air

## P

**PC:** Personal Computer, desktop or laptop PC

**PoE:** Power over Ethernet: Technology for local area networks (LAN) that provides the electrical power for a device over the Ethernet cable.

**Power:** A term describing the signal level in the RF domain or defining the length of the I/Q vector in the Baseband domain.

**product page:** A designation of the R&S NRPM product page.

## R

**R&S NRP-Toolkit:** Software package, which provides drivers for Linux, Mac OS X or MS Windows.

**Remote control:** The operation of the R&S NRPM by remote control commands or programs to perform automated tests. The instrument is connected to a system controller via LAN/VXI-11, GPIB or USB using Virtual Instrument Software Architecture (VISA). The instrument is controlled either directly, or supported by instrument drivers.

**RF:** Radio Frequency

**RF shielded box:** Anechoic test box with very low reflectivity. Provides a shielded test environment for OTA measurements of radio frequencies.

**RF test chamber:** Larger anechoic RF test chamber up to RF test room sizes with very low reflectivity. Provides a shielded test environment for OTA measurements of radio frequencies.

**rsu:** Rohde & Schwarz Update. A file format which contains updated device software. Processed by a firmware update program.

## S

**Shielded box:** See anechoic chamber.

**Shielded cube:** See anechoic chamber.

## T

**Trigger:** Internally generated or externally supplied signal which starts signal generation at a particular point in time.

**Trigger event:** A trigger event is caused by the received trigger signal or executed manual trigger.

## U

**USB:** Universal Serial Bus. A standard type of connection for many different kinds of devices.

**USBTMC:** (USB Test & Measurement Class)
A protocol built on top of USB for communication with USB devices. Using VISA library, it supports service request, triggers, and other specific operations, similar to GPIB.

## V

**VISA:** Virtual Instrument Software Architecture
A standardized software interface library providing input and output functions to communicate with instruments.

## W

**WPTC:** (Wireless Performance Test Chamber)
Anechoic chamber with very low reflectivity. Provides a shielded test environment for OTA measurements of radio frequencies.

# List of commands

# Index

## U



## V



## W



## Z