R&S®NRT-Z14/44
Directional Power Sensor
Getting Started

ROHDE&SCHWARZ

Make ideas real

This document describes the following directional power sensor models and accessories:

- R&S®NRT-Z14 (1444.0006K02)
- R&S®NRT-Z44 (1444.0012K02)
- R&S®NRT-Z5 (1400.6909K02)

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 chapters.

Intended use

The R&S NRT-Zxx directional power sensor is intended for power and reflection measurements in development and for monitoring and maintenance purposes. The supported base units are listed in the data sheet. Observe the operating conditions and performance limits stated in the data sheet.

Target audience

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

Main applications are continuous monitoring of transmitter systems and power measurements with digital modulation. A profound knowledge of the intended application and test setup is required.

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 Chapter 1.1, "Safety instructions", on page 5. The same information is provided in many languages as printed "Safety Instructions". The printed "Safety Instructions" 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 data sheet, manuals and the printed "Safety Instructions". If you are unsure about the appropriate use, contact Rohde & Schwarz customer service.

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 data sheet. 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 service 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 such as altitude, operating temperature and climatic loads; see the data sheet.

Connecting directional power sensors

During the measurement, the RF power flow can be high. Connect both RF connectors tightly to avoid power leakage. Contact with leaking RF power can cause electric shock and severe skin burns. Take the following measures for your safety:

- Before switching on the RF power of your test setup, make sure that both RF ports of the power sensor are connected securely as described in the product documentation.
- Do not touch the RF ports when the RF power is switched on.
- Never exceed the permissible continuous power that is shown in the diagram on the back of the power sensor.
- Before disconnecting one or both RF ports of the power sensor, switch off the RF power.

Meaning of safety labels

Safety labels on the product warn against potential hazards.

⚠️	Potential hazard
	Read the product documentation to avoid personal injury or product damage.

1.2   Labels on the product

Labels on the product inform about:

- Personal safety
  See "Meaning of safety labels" on page 6.
- Environment safety
  See Table 1-1.
- Identification of the product
  The front label of the power sensor contains the serial number that uniquely identifies the power sensor.
- Power handling capacity
  See "Signal input and output levels" on page 14.

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 service life.
	For more information, see the user manual.

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.

CAUTION

Potentially hazardous situation. Could result in minor or moderate injury if not avoided.

NOTICE

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

2 Welcome

This chapter provides an overview of the user documentation and an introduction to the R&S NRT-Zxx power sensor.

2.1 Documentation overview

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

www.rohde-schwarz.com/manual/nrt-z_nap-z

Further documents are available at:

www.rohde-schwarz.com/product/nrt-z_nap-z

2.1.1 Getting started manual

Introduces the R&S NRT-Zxx and describes how to set up and start working with the product. Includes basic operations and general information, e.g. safety instructions, etc. A printed version is delivered with the power sensor.

2.1.2 User manual

Contains the description of all R&S NRT-Zxx functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance and interfaces. Includes the contents of the getting started manual.

2.1.3 Tutorials

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

2.1.4   Instrument security procedures

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

2.1.5   Printed safety instructions

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

2.1.6   Data sheets and brochures

The data sheet contains the technical specifications of the R&S NRT-Zxx. 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.

www.rohde-schwarz.com/brochure-datasheet/nrt-z_nap-z

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

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

www.rohde-schwarz.com/application/nrt-z_nap-z

2.2   Key features

The R&S NRT-Zxx power sensors support the following measurements:

Average power (RMS value)

Returns the average value of the power for any type of measurement signal — modulated, unmodulated or several carriers.

Peak envelope power (PEP) and crest factor

Both parameters provide information on the peak power of a modulated envelope and describe the overdrive characteristics of transmitter output stages. The power sensor outputs the result of the crest factor measurement as the ratio of peak envelope power (PEP) to average power. In the graphical user interface of the base unit or the R&S Virtual NRT, the crest factor is displayed as a logarithmic ratio in dB. Measurements are performed using a video bandwidth that is adjustable in several steps, so that even short-time and high-power peaks can be determined.

Average burst power

Used to measure modulated and unmodulated bursts based on the average power and the duty cycle. The duty cycle can be defined or determined automatically by the power sensor.

Complementary cumulative distribution function (CCDF)

Measures the probability of the peak envelope power exceeding a preset threshold so that the amplitude distribution of signals with an unknown envelope can be determined.

Voltage standing wave ratio (VSWR), reflection coefficient, return loss

These parameters provide information on the matching of the load. The power sensor derives these parameters from the average power measurement in forward and reverse direction.

3 Preparing for use

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

3.1 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.

3.2 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 data sheet.

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 data sheet.

- 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.

3.3   Considerations for test setup

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.

Signal input and output levels

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

Information on power handling capacity is given also on the back of the power sensor. A derating diagram shows the power handling capacity of the power sensor maximum forward power versus frequency, under different conditions such as temperature and VSWR of the load.

3.4   Connecting to source and load

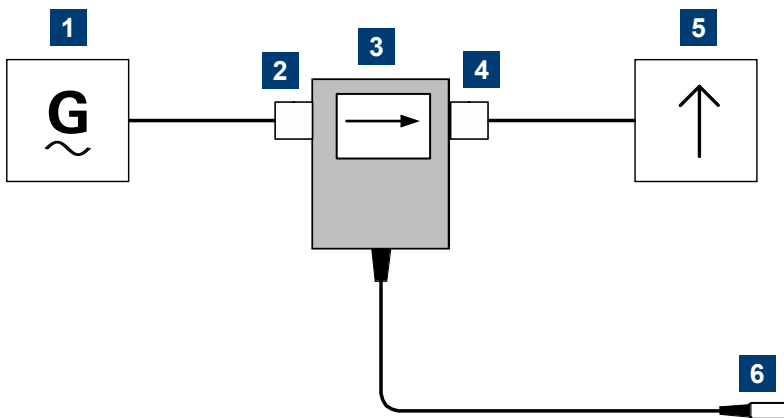The arrow on the power sensor front side shows the forward power flow.

Figure 3-1: Connecting to source and load

1 = source
2 = port 1 (RF connector)
3 = R&S NRT-Zxx directional power sensor
4 = port 2 (RF connector)
5 = load
6 = host interface connector

Connect the R&S NRT-Zxx as shown in Figure 3-1 and described in the following step-by-step instructions to avoid damage to the power sensor and to use all measurements.

If you want to measure an average of forward power below 30 W with high accuracy and matching measurements are of secondary importance, you can connect the R&S NRT-Zxx the other way around.

To connect to the DUT

1. Connect RF connector (2, port 1) to the source.

   a) Insert RF connector (2) straight into the RF connector of the source. Take care not to tilt the R&S NRT-Zxx directional power sensor.
   b) Tighten the RF connector securely by hand.

2. Connect RF connector (4, port 2) to the load.

   a) Insert RF connector (4) straight into the RF connector of the load. Take care not to tilt the R&S NRT-Zxx directional power sensor.
   b) Tighten the RF connector tightly by hand.
      See "Connecting directional power sensors" on page 6.

To disconnect from the DUT

1. **CAUTION!** Risk of electric shock and severe skin burns. See "Connecting directional power sensors" on page 6.

   Switch off the RF power before touching the RF connectors.

2. Unscrew the RF connectors by hand.

3.5   Connecting to a computer or base unit

For connecting the power sensor to a computer or base unit, use the host interface. See Chapter 4.2, "Host interface", on page 20.

For operating the power sensor, you can choose from various possibilities. For details, see Chapter 5, "Operating concepts", on page 23.

3.5.1   Computer

As a controller, you can use a computer with a Microsoft Windows operating system, equipped with R&S Virtual NRT or remote control software.
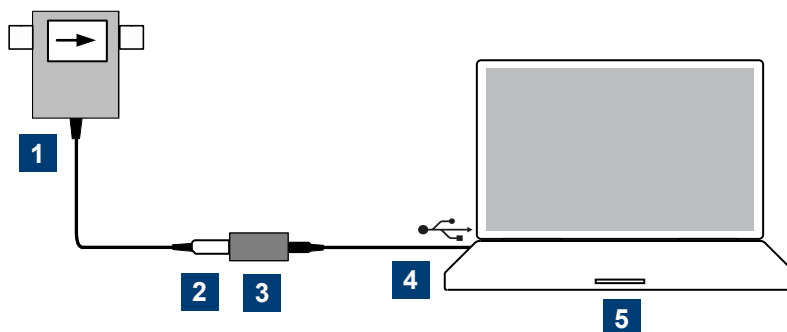

Figure 3-2: Connecting to computer

1 = R&S NRT-Zxx directional power sensor
2 = host interface connector → sensor interface
3 = R&S NRT-Z5 USB interface adapter
4 = USB connector → USB port
5 = computer

To connect to a computer

1. Meet the prerequisites of the R&S NRT-Z5 USB interface adapter described in Chapter 4.4, "R&S NRT-Z5 USB interface adapter", on page 20.

2. Connect the host interface connector of the R&S NRT-Zxx directional power sensor, (2) in Figure 3-2, to the sensor interface of the R&S NRT-Z5 USB interface adapter.

3. Connect the USB connector of the R&S NRT-Z5 USB interface adapter to a USB port of the computer.

Further information:

- Chapter 5.2, "R&S Virtual NRT", on page 24
- Chapter 5.3, "Remote control", on page 26

3.5.2   Base unit

You can operate the R&S NRT-Zxx on an R&S NRT2 or R&S NRX base unit. The R&S NRX base unit must be equipped with the interface for R&S NRT-Z sensors (R&S NRX-B9).
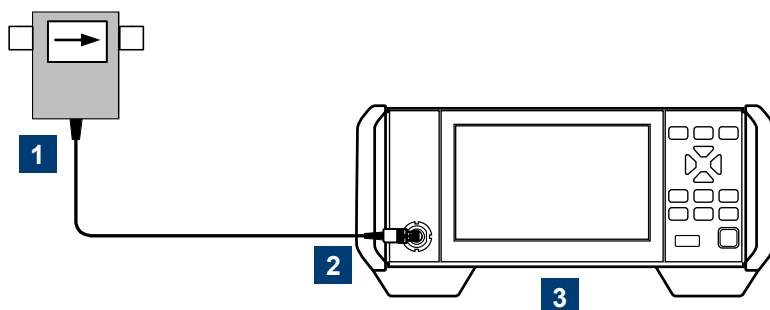
Figure 3-3: Connecting to base unit

1 = R&S NRT-Zxx directional power sensor
2 = host interface connector → sensor interface
3 = base unit

To connect to a base unit

► Connect the host interface connector of the R&S NRT-Zxx directional power sensor, (2) in Figure 3-3, to the sensor interface of the base unit.

The base unit recognizes the power sensor a few seconds after the connection is made or after power-up and immediately starts to measure.

If the base unit does not recognize the power sensor, check the baud rate setting.
See the user manual.

Further information:

- Chapter 5.1, "Base unit", on page 23
- User manual of the base unit

3.5.3   Legacy setups

To support legacy setups, you can also connect the power sensor to the following legacy adapters and instruments:

- R&S NRT-Z3 interface adapter
  To connect to a computer with standard RS-232 interface.
- R&S NRT-Z4 PCMCIA interface adapter
  To connect to a computer with a PCMCIA type II slot.
- R&S NRT
  Legacy base unit

4   Power sensor tour

This chapter provides an overview of the available connectors of the power sensor.

The meanings of the labels on the product are described here and in Chapter 1.2, "Labels on the product", on page 7.
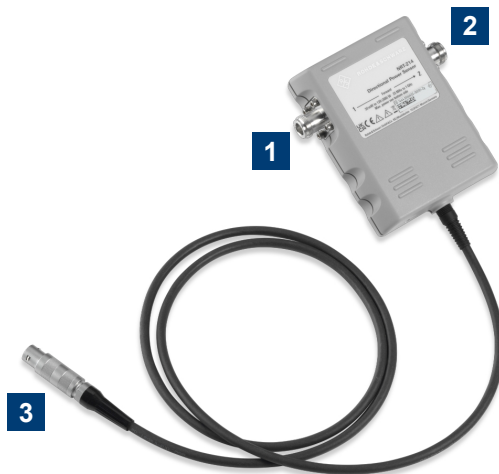

Figure 4-1: R&S NRT-Zxx directional power sensor, front side

1 = port 1 (RF connector) → connect to source
2 = port 2 (RF connector) → connect to load
3 = host interface

4.1   RF connectors

Always switch off the RF power before touching the RF connectors. See "Connecting directional power sensors" on page 6.

The RF connectors are used for connecting the power sensor between source and load. To help connecting the power sensor correctly, the RF connectors are assigned a number, indicated on the front label, see Figure 4-1.

See Chapter 3.4, "Connecting to source and load", on page 14.

4.2 Host interface

Used for establishing a connection between the power sensor and a computer or base unit. The connection is used for:

- Remote control of the power sensor via the serial interface (RS-422).
- Supplying the power sensor with DC power.

See Chapter 3.5, "Connecting to a computer or base unit", on page 16.

4.3 Power handling capacity

Located on the back of the power sensor, there is a derating diagram that shows the power handling capacity of the power sensor, forward power in W versus frequency. It is also dependent on ambient temperature and the VSWR of the load. Further information on signal levels is provided in the data sheet. See also "Signal input and output levels" on page 14.

4.4 R&S NRT-Z5 USB interface adapter

This adapter connects the host interface of the R&S NRT-Z5 USB interface adapter to the USB port of a computer.
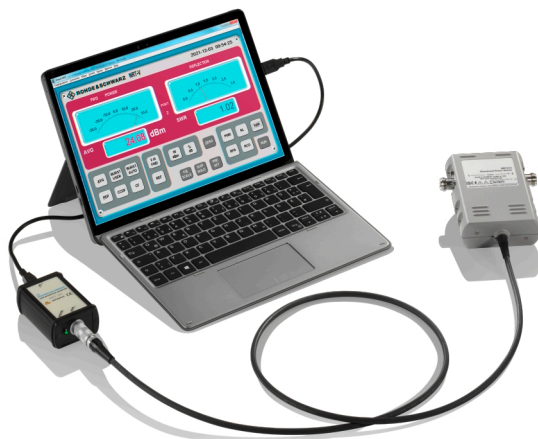
Prerequisites

- The USB port of the computer must be capable to supply at least 500 mA. If necessary, use a self-powered USB hub.
- The drivers for the R&S NRT-Z5 USB interface adapter are installed on the computer.

To install the drivers for the R&S NRT-Z5 USB interface adapter

► Proceed as described in the technical information delivered with the R&S NRT-Z5 USB interface adapter.

For a detailed setup, see Chapter 3.5.1, "Computer", on page 16.

5   Operating concepts

5.1   Base unit
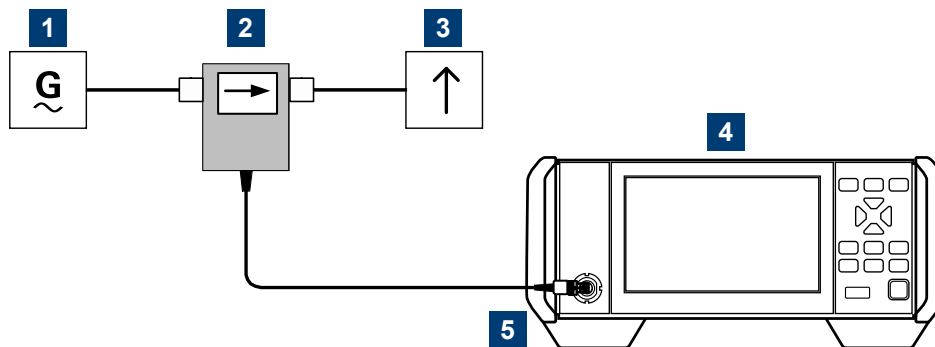
See also Chapter 3.5.2, "Base unit", on page 17.

Setup

Figure 5-1: Setup for base unit

1 = signal source
2 = R&S NRT-Zxx directional power sensor
3 = load
4 = base unit
5 = host interface connector → sensor interface

Communication between the R&S NRT-Zxx directional power sensor and a base unit is only possible with a baud rate setting of 38400 Bd. This setting is the factory default that must be restored if the setting was changed. If the R&S NRT-Zxx directional power sensor is not recognized by the base unit, check that the baud rate setting of the R&S NRT-Zxx directional power sensor is 38400 Bd.

For details on checking and setting the baud rate, see the user manual > maintenance.

5.2　R&S Virtual NRT

R&S Virtual NRT is a Windows application provided by Rohde & Schwarz for controlling the R&S NRT-Zxx. R&S Virtual NRT provides a graphical user interface supporting:

- Manual operation of the main measurements. For information on the graphical user interface, see the R&S Virtual NRT help.

- Remote control, see Chapter 5.3.1, "Remote control using R&S Virtual NRT", on page 26.

Installing the program

R&S Virtual NRT is provided on the Rohde & Schwarz website as a separate standalone installation package,

https://www.rohde-schwarz.com/software/nrt-z_nap-z/.

► Save the EXE file on your computer.

Required equipment

- R&S NRT-Zxx power sensor

- R&S NRT-Z5 USB interface adapter to connect the power sensor to the computer; alternatively, you can use a legacy adapter, see Chapter 3.5.3, "Legacy setups", on page 18.

- Computer with Microsoft Windows operating system and the drivers for the R&S NRT-Z5 USB interface adapter installed, see "To install the drivers for the R&S NRT-Z5 USB interface adapter" on page 21.
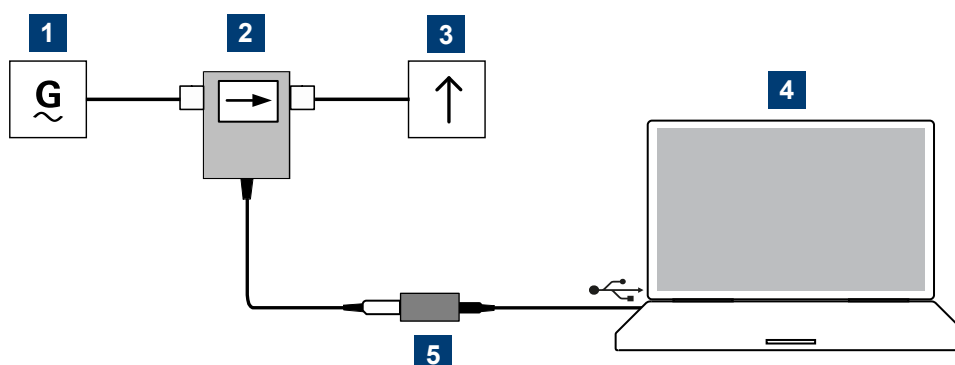
Setup

Figure 5-2: Setup for R&S Virtual NRT

1 = signal source
2 = R&S NRT-Zxx directional power sensor
3 = load
4 = computer with installed R&S Virtual NRT
5 = R&S NRT-Z5 USB interface adapter

To start a measurement

1. Connect the R&S NRT-Zxx to the computer as shown in "Setup" on page 24. For detailed descriptions, refer to:
    - Chapter 3.4, "Connecting to source and load", on page 14
    - Chapter 3.5.1, "Computer", on page 16

2. Switch on the test signal of the signal source.

3. Start R&S Virtual NRT.

    A few seconds after the user interface is displayed, when the pointers of the analog indication start wriggling, the power sensor is ready for operation. For further instructions, see the R&S Virtual NRT help.
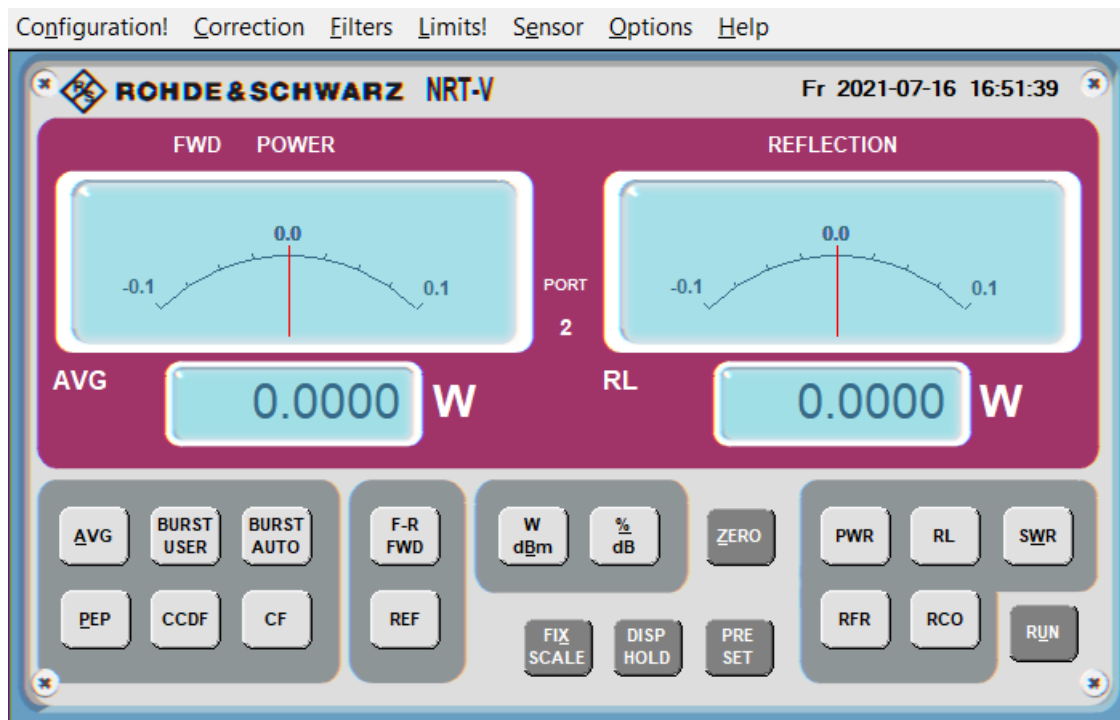
If communication with the power sensor could not be established, the display is dimmed and the automatic configuration of the interface failed. Proceed with "To establish the communication" on page 26.

To establish the communication

1. In the "Options" menu, select "RS-232".
   Click "Auto Config" to start the automatic configuration again.

2. If automatic configuration does not work, configure the interface settings manually:

   a) Set baud rate to *38400*.
      This value is the factory-set value of the R&S NRT-Zxx.
      If you want to check the baud rate, proceed as described in the user manual.
   b) Under "COM port", select the virtual COM port that is assigned to the R&S NRT-Z5 USB interface adapter.
   c) Click "OK".
   d) Click "RUN".

5.3   Remote control

Using remote control, you can integrate the R&S NRT-Zxx directional power sensors into a remote-controlled measurement system or use functions that are not available in manual operation. You can monitor the power sensor and support the development of your own test program.

Further information:
- Chapter 3.5.1, "Computer", on page 16
- User manual

5.3.1   Remote control using R&S Virtual NRT

In R&S Virtual NRT, remote control is called *direct communication*. R&S Virtual NRT works like a terminal program, but also manages the configuration of the host (computer) and the initialization of the power sensor. For general information on R&S Virtual NRT, see Chapter 5.2, "R&S Virtual NRT", on page 24.

To communicate directly

1. Start as described in "To start a measurement" on page 25.

2. Wait until you can see the measurement results.

3. In the "Options" menu, select "Direct Communication".

   The "Direct Communication" dialog is displayed. Any running measurements are interrupted.

4. In the "Input" field, enter a command, for example `ID`.

5. Click "SEND".

   In the "Output" field, the response of the power sensor is displayed.

6. Click "STOP REC" to terminate the ready-to-receive state of R&S Virtual NRT before sending a new command.

7. For each command you want to send, repeat step 4 to step 6.

8. If you want to clear the receiver protocol displayed in the "Output" field, click "CLEAR".

9. Click "CLOSE" to return to manual operation.

5.3.2   Remote control using terminal program

You can use a terminal program of your choice.

5.3.2.1   Interface settings

To set up the connection successfully, the interface settings of power sensor and computer must match.

Power sensor interface settings

- Parity: none
- Data bits: 8
- Stop bits: 1
- Start bits: 1
- Protocol: XON / XOFF

You can change the baud rate as described in the user manual.

Computer interface configuration

- Port connected to the power sensor

- Interface parameters same as for power sensor, see "Power sensor interface settings" on page 27.
- ASCII configuration: end of transmitted lines with LF

Example: Using the PuTTY terminal program

This example shows the configuration of the PuTTY terminal program (https://www.putty.org/).

1. Under "Session", configure as follows:

    a) "Serial line": Must match the COM port that is assigned to the serial adapter, usually R&S NRT-Z5 USB interface adapter. You can look up this information in the device manager of the operating system.
    b) Speed: Must match the baud rate setting of the power sensor.
    c) Connection type: "Serial"

2. If you want to reuse the session settings, you can save them:

    a) Under "Saved Sessions", enter the name.
    b) Click "Save".
    c) To load a session, double-click the list entry.
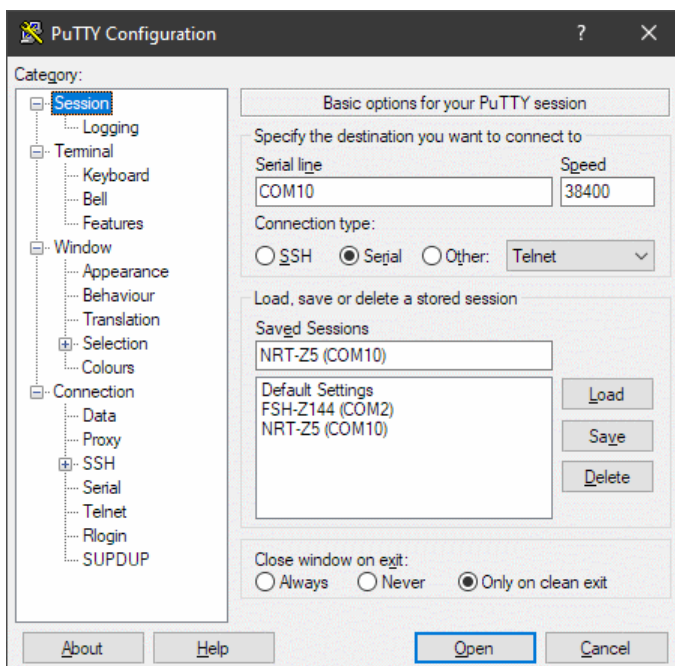
3. Recommendation for "Terminal" settings: Set both "Local echo" and "Local line editing" to "Force on". This way, you can see your input and edit the input line.
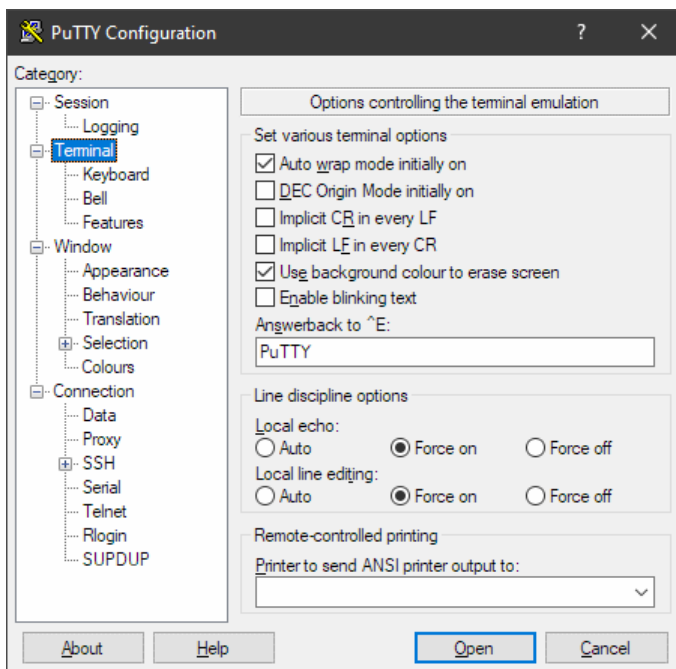
4. Under "Connection" > "Serial", configure the parameters of the serial inter-face.
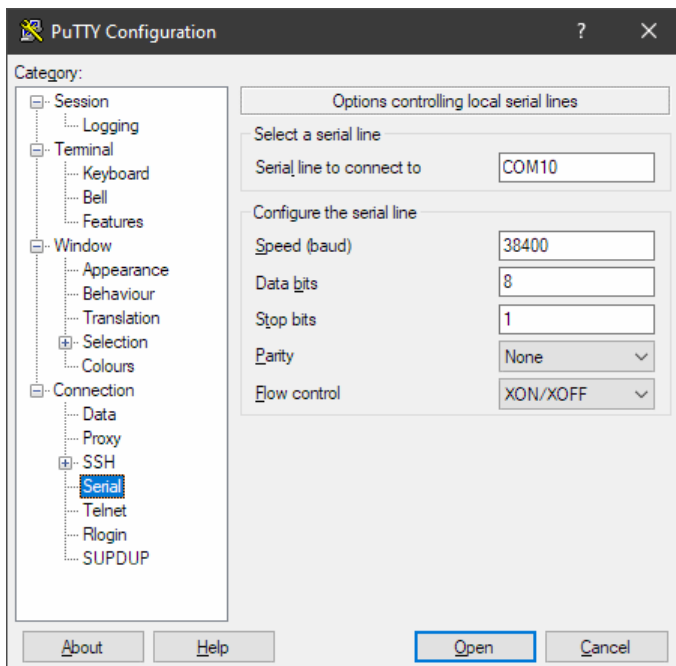
5.3.2.2   Testing the connection

On power-up, the R&S NRT-Zxx responds to commands with one or several lines, if the connection is working.

To ready the power sensor for measuring

1. Open the terminal program.

2. Send `appl`.

3. Wait for a response; see Chapter 5.3.2.3, "Behavior during booting", on page 31.

4. Repeat step 2 and step 3 until the power sensor responds with:
   `@8E oper` _____

   After receiving the response, you can make settings and query results.

To test the connection

1. Open the terminal program.

2. Enter the string `test`.

3. Confirm with the return key.

   The power sensor responds:
   ```
   @17 0 - This is a test string_____
   @18 1 - This is a test string_____
   @19 2 - This is a test string_____
   ...
   @37 97 - This is a test string_____
   @38 98 - This is a test string_____
   @39 99 - This is a test string_____
   ```
   See also Chapter 5.3.2.3, "Behavior during booting", on page 31.

To query the identification

► Send the `id` command.

   The power sensor responds with its identification string.
   Example: `@6E Rohde&Schwarz NRT-Z14 V3.00 2021-12-01____`

To query the last result

► Send `rtrg`.

   The power sensor responds with:
   `@11 +2.1234E+01 +2.1530E+01 __avrl15500 _____`

Interpreting the response:

- `+2.1234E+01`
  Result for measurement direction 1>2; in this example 21.234 W average power
- +2.1530E+01
  Result for measurement direction 2>1; in this example 21.53 dB return loss.
- __avrl15500

For further information, see the user manual.

5.3.2.3   Behavior during booting

On power-up, the power sensor is booting. During booting, you can load new firmware.

After booting is completed, a power-up test is performed for approx. 3 s.
Do not interrupt the power-up test. If you send the `appl` command during power-up test, the power sensor responds with:

`@9B busy`_____

After the power-up test is completed, send the `appl` command again to ready the power sensor for measuring. The power sensor responds with:

`@8C boot`_____

Now the power sensor is ready for operation. If you send the `appl` command again, the power sensor responds with:

`@8E oper`_____

Index

W