

# R&S®NRPC, R&S®Recal+ Power Sensor Calibration Kit and Calibration Software Manual



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Version 18

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This document describes the following models and options of the power sensor calibration kits:

- R&S®NRPC18 (1418.0931.03)
- R&S®NRPC33 (1418.0677.03)
- R&S®NRPC40 (1159.6802.03)
- R&S®NRPC50 (1159.6883.03)
- R&S®NRPC67 (1418.1567.02)
- R&S®NRPC-LS (1421.7004.02)
- R&S®NRPC18-B1 (1418.0954.03)
- R&S®NRPC33-B1 (1418.0683.03)
- R&S®NRPC40-B1 (1159.6819.03)
- R&S®NRPC50-B1 (1159.6890.03)
- R&S®NRPC67-B1 (1418.1550.02)

This document describes the R&S®Recal+ power sensor calibration software with version 5.04 and higher.

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1109.0930.02 | Version 18 | R&S®NRPC, R&S®Recal+

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

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# 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 NRPC power sensor calibration kits enable you to calibrate power sensors.

Connected between the RF output of a signal source and the sensor (DUT), you can use the calibration kits to perform both absolute accuracy and linearity calibration. A power meter indicates the power standard output. The R&S Recal+ software controls the calibration.

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 7. 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 skilled persons 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 and its accessories warn against potential hazards.

	<p>Potential hazard Read the product documentation to avoid personal injury or product damage.</p>
	<p>Hot surface Do not touch. Risk of skin burns. Risk of fire.</p>

## 1.2 Labels on the product

Labels on the product inform about:

- Personal safety  
See "[Meaning of safety labels](#)" on page 8.
- Environment safety  
See [Table 1-1](#).
- Identification of the product  
A sticker on the product shows the product ID, a combination of the order number and the serial number of the product. The serial number identifies the product uniquely.  
See also [Section 3, "Checking out the calibration kits and options"](#), on page 13.

**Table 1-1: Labels regarding environment safety**

	<p>Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its life. For more information, see "<a href="#">Disposing of electrical and electronic equipment</a>" on page 110.</p>
---	--

## 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](http://www.rohde-schwarz.com/key-documents), e.g. concerning:

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

## 2 Welcome

This section provides an introduction to the calibration kits.

In this manual, the term *R&S power sensor* is used for the power sensors of the NRP, R&S NRP-Z and R&S FSH-Z families. These power sensors are the main focus of this manual. Only section 9 describes the calibration of the older generations, the R&S NRV and R&S URV power sensors.

The term *R&S NRPC* is used for the R&S NRPC18, R&S NRPC33, R&S NRPC40, R&S NRPC50 and R&S NRPC67 calibration kits.

### 2.1 Documentation overview

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

[www.rohde-schwarz.com/manual/nrpc](http://www.rohde-schwarz.com/manual/nrpc)

Further documents are available at:

[www.rohde-schwarz.com/product/nrpc](http://www.rohde-schwarz.com/product/nrpc)

#### 2.1.1 Manual

Introduces the R&S NRPC and describes how to set up and start working with the product. Describes how to calibrate R&S power sensors using the R&S NRPC calibration kit together with the R&S Recal+ calibration software.

The user manual is also available for download or for immediate display on the internet.

#### 2.1.2 Printed safety instructions

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

#### 2.1.3 Instrument security procedures

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

#### 2.1.4 Product brochures

The brochures provide an overview of the products and their applications. They contain the technical specifications of the products and list the ordering information.

[www.rohde-schwarz.com/brochure-datasheet/nrpc](http://www.rohde-schwarz.com/brochure-datasheet/nrpc)

### 2.1.5 Calibration certificate

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

### 2.1.6 Release notes and open source acknowledgment (OSA)

The R&S NRPC firmware is installed on the R&S NRPC power standard. The corresponding release notes list new features, improvements and known issues of the current version.

The R&S NRPC firmware 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 available on the internet and also on the CD-ROM, included in the delivery.

[www.rohde-schwarz.com/firmware/nrpc](http://www.rohde-schwarz.com/firmware/nrpc)

### 2.1.7 R&S Recal+ calibration software

The R&S Recal+ calibration software is required on the controller. The corresponding release notes list new features, improvements and known issues of the current version, and describe the software installation and update. The integrated online help describes the user interface of the R&S Recal+ calibration software. The calibration process is described in this manual.

The R&S Recal+ calibration software is available on the internet and also on the CD-ROM, included in the delivery.

[www.rohde-schwarz.com/software/nrpc](http://www.rohde-schwarz.com/software/nrpc)

## 2.2 Key features

Various calibration kits are available for calibration of sensors depending on the frequency range. Calibration of the sensors is supported by the R&S Recal+ software. All the calibration kits are calibrated in a traceable manner by the accredited calibration laboratory D-K-15195-01-01 of Rohde & Schwarz. This laboratory is accredited by the Deutsche Akkreditierungsstelle GmbH (DAkkS) for the relevant measured quantities. The appendix to the accreditation certificate can be found on the internet at [www.dakks.de](http://www.dakks.de).

The calibration kits support the following functions:

- Calibration of absolute accuracy for power sensors with N-50  $\Omega$ , 3.5 mm, 2.92 mm, 2.4 mm, 1.85 mm connectors from DC to max. 67 GHz
- Linearity calibration with a level range of -60 dBm to +35 dBm at 1 GHz

- Recording the reflection with the R&S ZVX\_RECAL program module
- Calculating new correction factors for the data memories based on the calibration data. For certain sensors, calibration is performed without rewriting the data memory. See [Table 5-1](#) to [Table 5-6](#).
- Rewriting the data memories
- Report generation

## 3 Checking out the calibration kits and options

### To unpack and check

1. Unpack the R&S NRPC carefully.
2. Retain the original packing material. Use it when transporting or shipping the R&S NRPC 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.

### 3.1 R&S NRPC calibration kits



Figure 3-1: R&S NRPC calibration kit (example)

Table 3-1: Contents of the calibration kit box

Figure 3-1	Designation	R&S NRPC18	R&S NRPC33	R&S NRPC40	R&S NRPC50	R&S NRPC67
1	Microwave connecting cable	N (male) to N (male)	PC2.92 (male) to PC2.92 (male)	PC2.92 (male) to PC2.92 (male)	PC2.4 (male) to PC2.4 (male)	PC1.85 (male) to PC1.85 (male)
2	Adapter	N (male) to BNC (male)	N (male) to SMA (female)	N (male) to SMA (female)	N (male) to PC2.4 (female)	N (male) to PC2.4 (female)
3	Reference attenuator	20 dB	20 dB	20 dB	-	-

Figure 3-1	Designation	R&S NRPC18	R&S NRPC33	R&S NRPC40	R&S NRPC50	R&S NRPC67
4	Replacement adapter for the test port	-	PC2.4 (male) to PC3.5 (female)	PC2.4 (male) to PC2.92 (female)	PC2.4 (male) to PC2.4 (female)	PC1.85 (male) to PC1.85 (female)
5	CD-ROM	Contains manual, program and data				
6	Torque wrench					
7	Power standard, see <a href="#">Figure 3-2</a> .					
8	R&S NRPCx-B1 verification sensor	Optional, see <a href="#">Section 3.3, "Options for the R&amp;S NRPC calibration kits"</a> , on page 18.				
Not shown	Precision termination	50 Ω	-	-	-	-
Not shown	Adapter cable	Connects R&S FSH-Z sensors to the R&S NRPC				

The R&S NRPC calibration kits support the calibration of absolute accuracy. See also [Section 4.3, "Calibration of absolute accuracy"](#), on page 21.



**Figure 3-2: Power standard (example)**

- 1 = ["Accreditation information sticker"](#) on page 14
- 2 = test port; for connecting to DUT
- 3 = RF input; for connecting to generator RF output
- 4 = ["Product ID sticker"](#) on page 14

### Accreditation information sticker

Shows the following information from top to bottom: calibration certificate number without prefix, number of accredited calibration laboratory, date of the last accreditation.

### Product ID sticker

Shows the product ID, a combination of the order number and the serial number of the product. The serial number is unique for each product.

 ID: 1234.5678K02 - 123456 - Zd Serial number



For specifications such as max. input power, frequency range or test post power range, refer to the specifications documents. See also [Section 2.1.4, "Product brochures"](#), on page 10.

For maximum measurement accuracy, tighten the RF connector using a torque wrench with a nominal torque as specified in [Table 3-2](#).

**Table 3-2: R&S NRPC RF connector type**

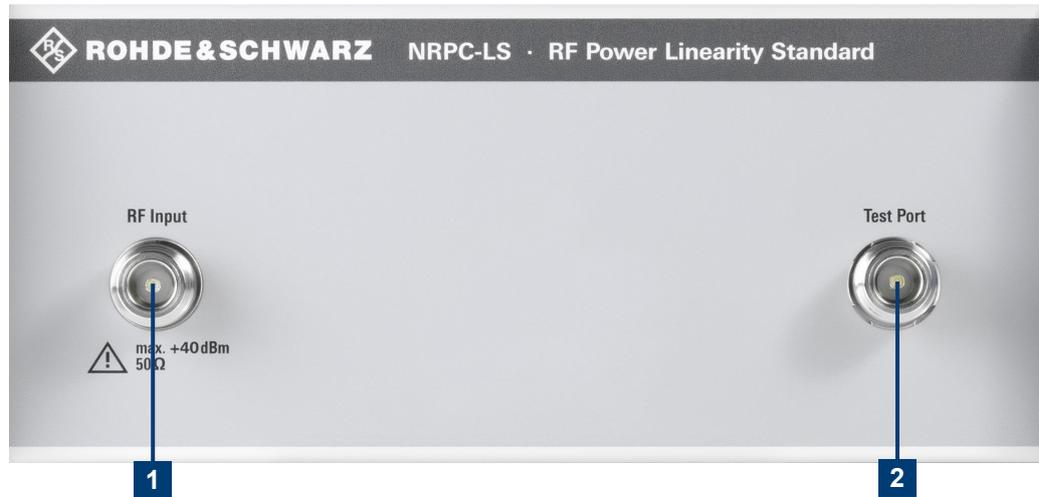
Calibration kit	RF connector type	Tightening torque
R&S NRPC18	N-50 $\Omega$	1.3 Nm (11.5 lbf in) to 1.7 Nm (15 lbf in)
R&S NRPC33	3.5 mm	0.90 Nm (8 lbf in)
R&S NRPC40	2.92 mm	0.90 Nm (8 lbf in)
R&S NRPC50	2.4 mm	0.90 Nm (8 lbf in)
R&S NRPC67	1.85 mm	0.90 Nm (8 lbf in)

The R&S NRPC calibration kits use the technology in the NRP thermal sensors. The display of the RF power measurand takes place here entirely in the sensor all the way through the numerical measurement result. The R&S NRX base unit is used only to set the sensor parameters and to display the measured value computed in the sensor. In this manner, any influence of the power meter base unit on the measured value is eliminated for the R&S NRPC calibration kits. All the necessary correction factors including the S-parameters for the reference attenuator are saved in the data memory of the power standard.

Upon delivery, the power standards contain all the necessary data, correction and characteristic data.

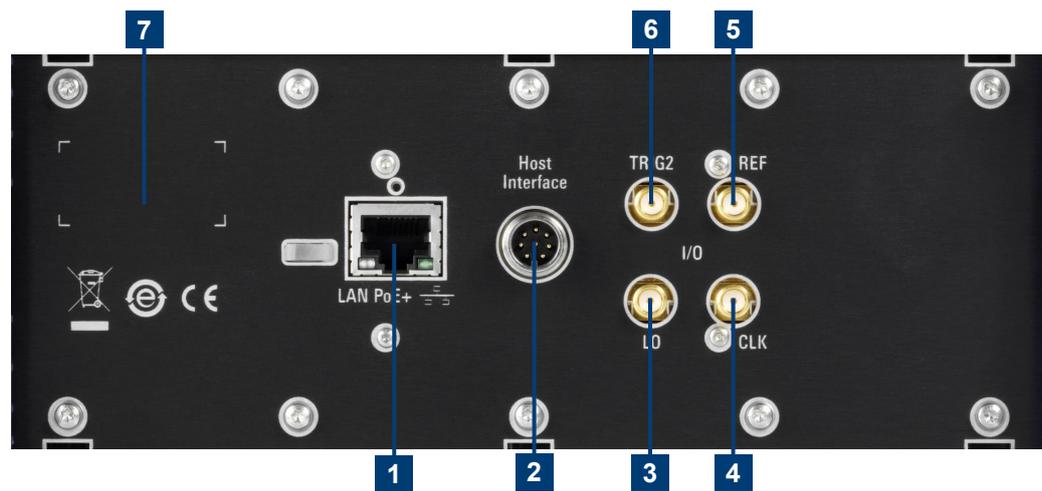
## 3.2 R&S NRPC-LS linearity standard

The R&S NRPC-LS calibration kit supports the linearity check at 1 GHz. See also [Section 4.4, "Linearity calibration"](#), on page 22.



**Figure 3-3: R&S NRPC-LS front view**

1 = RF input, to connect to generator RF output  
2 = test port to connect to DUT



**Figure 3-4: R&S NRPC-LS rear view**

1 = "LAN PoE+ interface" on page 17  
2 = "Host interface" on page 17  
3 = "Local oscillator I/O (LO)" on page 17  
4 = "Clock I/O (CLK)" on page 17  
5 = "Reference I/O (REF)" on page 17  
6 = "Trigger 2 I/O (TRIG2)" on page 17  
7 = "Product ID sticker" on page 14



For specifications such as max. input power, frequency range or test post power range, refer to the specifications documents. See also [Section 2.1.4, "Product brochures"](#), on page 10.

The maximum input power is also printed on the housing below the RF input. Exceeding the maximum input power can damage the product.

**RF connector**

N-50  $\Omega$  RF connector.

For maximum measurement accuracy, tighten the RF connector using a torque wrench with a nominal torque of 1.3 Nm (11.5 lbf in) to 1.7 Nm (15 lbf in).

**LAN PoE+ interface**

1 gigabit LAN interface (1000BASE-T). The assignment of the RJ.45 CAT5 connector supports twisted-pair UTP/STP cables in a star configuration (UTP stands for "unshielded twisted pair", and STP for "shielded twisted pair").



Electromagnetic interference (EMI) can affect the measurement results. To avoid any impact, use category 5 cables or better.

The power for the sensor is supplied over the LAN PoE+ interface.

Network status LED:

Shows whether the LAN connection to the network is established properly or not.

Indication		State
	Green	The sensor is correctly connected to the network. It has been assigned a valid IP address, either manually or via DHCP.
	Red	The sensor is not connected to the network correctly. Either the connection is erroneous or the sensor has not been assigned a valid IP address yet.

**Host interface**

The 8-pole male sensor connector (M12) is used to connect the sensor to a base unit.

**Local oscillator I/O (LO)**

The female SMA connector is used as an input or output for the local oscillator (LO) signal.

**Clock I/O (CLK)**

The female SMA connector is used as an input or output for the sampling clock.

**Reference I/O (REF)**

The female SMA connector is used as an input or output for the reference clock.

**Trigger 2 I/O (TRIG2)**

The female SMA connector is used as an input or output for a trigger signal.

### 3.3 Options for the R&S NRPC calibration kits

The R&S NRPCx-B1 option is an optional part of the R&S NRPC calibration kit. It is a verification sensor, a thermal sensor, for the associated power standard, see also [Table 3-3](#).



For specifications such as max. input power, frequency range or test post power range, refer to the specifications documents. See also [Section 2.1.4, "Product brochures"](#), on page 10.

For maximum measurement accuracy, tighten the RF connector using a torque wrench with a nominal torque as specified in [Table 3-3](#).

**Table 3-3: R&S NRPCx-B1 RF connector type**

Calibration kit	RF connector type	Tightening torque	Associated power standard
R&S NRPC18-B1	N-50 $\Omega$	1.3 Nm (11.5 lbf in) to 1.7 Nm (15 lbf in)	R&S NRPC18
R&S NRPC33-B1	3.5 mm	0.90 Nm (8 lbf in)	R&S NRPC33
R&S NRPC40-B1	2.92 mm	0.90 Nm (8 lbf in)	R&S NRPC40
R&S NRPC50-B1	2.4 mm	0.90 Nm (8 lbf in)	R&S NRPC50
R&S NRPC67-B1	1.85 mm	0.90 Nm (8 lbf in)	R&S NRPC67

### 3.4 Recognizing power standard models

There are two generations of the R&S NRPC power standards. The first generation is based on a thermal R&S NRP-Z sensor. The second generation is based on a thermal NRP sensor. All products of the first generation are discontinued. You can recognize the generation at the last two digits of the part number, as shown in [Table 3-4](#).

**Table 3-4: Power standard models**

R&S NRPC	Part number	First generation	Second generation	Discontinued product
R&S NRPC18	1418.0948.02	x		x
	1418.0948.03		x	
R&S NRPC33	1418.0660.02	x		x
	1418.0660.03		x	
R&S NRPC40	1159.6625.02	x		x
	1159.6625.03		x	
R&S NRPC50	1159.6725.02	x		x
	1159.6725.03		x	
R&S NRPC67	1418.1573.02		x	

The same applies to the R&S NRPCx-B1 options, see [Table 3-5](#).

**Table 3-5: Verification sensor models**

R&S NRPCx-B1	Part number	First generation	Second generation	Discontinued product
R&S NRPC18-B1	1418.1044.03	x		x
	1418.1044.04		x	
R&S NRPC33-B1	1418.0819.02	x		x
	1418.0819.03		x	
R&S NRPC40-B1	1418.0602.03	x		x
	1418.0602.04		x	
R&S NRPC50-B1	1418.0525.02	x		x
	1418.0525.03		x	
R&S NRPC67-B1	1418.1638.02		x	

## 4 Information and instructions on calibration

### 4.1 Warm-up time for devices under test (DUTs)

The R&S power sensors require a warm-up time of at least one hour after startup to attain their operating temperature. If it is frequently necessary to calibrate a series of sensors, let the uncalibrated sensors warm up while calibration is being performed on another one. In this application, you can connect them either to a multichannel R&S NRX (R&S NRX-B2 and R&S NRX-B5 option) or to a PC, preferably using the four-channel R&S NRP-Z5 USB sensor hub.

Simply connecting the sensor to the PC is not sufficient for warm-up. Instead, the sensor processor, which is the main source of heat for the sensor, must be placed in a typical operating state.

1. Connect the sensor.
2. In the Windows device manager, USB controller device group, check the status of the sensor. Wait until Windows recognizes the sensor.

If the sensor is recognized, the sensor is properly numbered.

3. Open the Windows device manager.
4. In the USB controller device group, enter the number.

**Note:** For the prerequisites for numbering, see ["Software requirements"](#) on page 26.

For the R&S NRV and R&S URV5 sensors, it is adequate to wait for two minutes after connection to the R&S NRVD.

### 4.2 Reflection measurement

Always measure the reflection of a sensor from two perspectives. One reason is that the reflection is an important device property. The other reason is that the reflection data in complex notation can be used to reduce the measurement errors resulting from mismatching during calibration of absolute accuracy, see [Section 6.2.4, "Checking the absolute accuracy"](#), on page 48. Reflection measurement is supported by the R&S ZVX\_RECAL program module together with selected network analyzers from Rohde & Schwarz. Methods for integrating reflection data from other network analyzers into the R&S Recal+ software are described in [Section 8.1, "Reflection"](#), on page 63.

## 4.3 Calibration of absolute accuracy

### 4.3.1 Refreshing the data set of the device under test

When absolute accuracy is checked, the power reading of the DUT is compared with the power reading of a power standard over the entire frequency range of the DUT. The R&S Recal+ software automatically performs a tolerance test. The test provides an indication of whether the sensor can be considered to comply with the specifications at the time point of delivery at the individual frequency points.

To ensure compliance with specifications for the following calibration interval, it is necessary for most sensors to readjust also the saved correction factors (calibration data). After the readjustment, the errors that are measured compared to the power standard disappear. You can achieve that in a subsequent measurement. Devices under test that are calibrated or adjusted in this manner reliably conform to the uncertainties specified in the specifications document.

For a few sensors, the compliance with specifications is ensured if the tolerance limits used in calibration of absolute accuracy are met. In this case, you cannot rewrite the correction factor memory. These sensor types are indicated accordingly in the "Absolute accuracy" or "Adjustment" column, see [Table 5-1](#) to [Table 5-6](#).

### 4.3.2 Gamma correction

Correction of the mismatch between the device under test and the power standard, gamma correction for short, generally reduces the influence of the mismatch by an order of magnitude. This correction is recommended in all cases, and it is even mandatory for some sensor types. These sensors are designated accordingly in [Table 5-1](#) to [Table 5-6](#). You can enable the gamma correction easily in the R&S Recal+ software, but it does require the availability of reflection values for the device under test in complex notation. Reflection measurement is supported by the R&S ZVX\_RECAL program module in conjunction with selected network analyzers from Rohde & Schwarz.

### 4.3.3 R&S power sensors with attenuator

Calibration is different with the R&S NRP18S-xx and R&S NRP-Z22/23/24/92 sensors that consist of a power sensor with an attenuator connected to the input. The attenuator is treated as a connectable S-parameter device for which separate correction factors are present in the data memory for the sensor. If the uncertainties specified for the power sensor and attenuator must match after the calibration, refresh the correction factors of both when calibrating these sensors.

Like all the other R&S power sensors, calibration of the power sensors is supported by the R&S Recal+ software. However, calibration of the attenuators is not supported. Since the risk of significant measurement errors is higher compared to power calibration, we recommend that the calibration of the attenuators is handled only by experi-

enced personnel. See also section [Section 8.2, "S-parameter file for sensors with attenuators"](#), on page 78.

To check the correctness of the existing calibration values for the attenuator roughly, run a check measurement on the power sensor with the attenuator screwed on, using the R&S Recal+ software.

#### 4.3.4 R&S NRV-Z and R&S URV5-Z diode sensors

Some of these sensors require a power level of less than 10  $\mu\text{W}$  for calibration of absolute accuracy. If so, connect the reference attenuator to the output of the power standard to reduce the power level.

### 4.4 Linearity calibration

For most DUTs, calibration of the linearity is used only to check that the sensor is functioning properly. Thus, the check for compliance with tolerance limits that is performed by the R&S Recal+ software is fully adequate. In such cases, you cannot refresh the set of correction factors.

## 5 Measurement equipment and setups

### 5.1 Supported R&S power sensors

#### 5.1.1 Calibration of absolute accuracy with R&S NRPC calibration kit

Table 5-1: Power sensors supported by the R&S NRPC18 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRP6A(N)	✓	✓	-	8 kHz to 6 GHz
R&S NRP18A(N)	✓	✓	-	8 kHz to 18 GHz
R&S NRP8E	✓	✓	-	10 MHz to 8 GHz
R&S NRP18E	✓	✓	-	10 MHz to 18 GHz
R&S NRP18P	✓	✓	-	50 MHz to 18 GHz
R&S NRP8S(N)	✓	✓	-	10 MHz to 8 GHz
R&S NRP18S(N)	✓	✓	-	10 MHz to 18 GHz
R&S NRP18S-10/20/25	✓	✓	-	10 MHz to 18 GHz
R&S NRP18T(N)	✓	✓	✓	10 MHz to 18 GHz
R&S FSH-Z1	✓	✓	-	10 MHz to 8 GHz
R&S FSH-Z18	✓	✓	-	10 MHz to 18 GHz
R&S NRP-Z11	✓	✓	-	10 MHz to 8 GHz
R&S NRP-Z21/22/23/24	✓	✓	-	10 MHz to 18 GHz
R&S NRP-Z27	✓	✓	-	DC to 18 GHz
R&S NRP-Z211	✓	✓	-	10 MHz to 8 GHz
R&S NRP-Z221	✓	✓	-	10 MHz to 18 GHz
R&S NRP-Z51 (02, 62)	✓	✓	-	10 MHz to 18 GHz
R&S NRP-Z51 (03)	✓	✓	✓	10 MHz to 18 GHz
R&S NRP-Z81	✓	✓	-	50 MHz to 18 GHz
R&S NRP-Z91 (02, 04)	✓	✓	-	9 kHz to 6 GHz
R&S NRP-Z91 (08)	-	✓	-	10 MHz to 8 GHz
R&S NRP-Z92	✓	✓	-	9 kHz to 6 GHz
R&S NRV-Z1/2	✓	✓	-	10 MHz to 18 GHz

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRV-Z4/5	✓	✓	-	100 kHz to 6 GHz
R&S NRV-Z7/8	✓	✓	-	10 MHz to 13 GHz
R&S NRV-Z31/32/33	-	✓	-	30 MHz to 6 GHz
NRV-Z51 (02, 04)	✓	✓	-	10 MHz to 18 GHz
R&S NRV-Z51 (06)	✓	✓	-	1 kHz to 6 GHz
R&S NRV-Z53/54	✓	✓	-	10 MHz to 18 GHz
R&S NRV-Z53/54	✓	✓	-	10 MHz to 18 GHz
R&S NRV-Z1/2	✓	✓	-	10 MHz to 18 GHz

Table 5-2: R&amp;S URV voltage sensors supported by the R&amp;S NRPC18 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S URV5-Z2 (02, 05)	-	✓	-	9 kHz to 3 GHz
R&S URV5-Z2 (04)	-	✓	-	9 kHz to 1 GHz
R&S URV5-Z2 (55, 56)	-	✓	-	9 kHz to 2 GHz
R&S URV5-Z4 (02, 05)	-	✓	-	100 kHz to 3 GHz
R&S URV5-Z4 (04)	-	✓	-	100 kHz to 2 GHz
R&S URV5-Z4 (55, 56)	-	✓	-	100 kHz to 2 GHz
R&S URV5-Z5 (55)	✓	✓	-	10 MHz to 18 GHz
R&S URV5-Z7	-	✓	-	20 kHz to 1 GHz
R&S URY-Z2	-	✓	-	9 kHz to 2 GHz
R&S URY-Z4	-	✓	-	100 kHz to 2 GHz
R&S URY-Z7	-	✓	-	20 kHz to 1 GHz

Table 5-3: Power sensors supported by the R&amp;S NRPC33 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRP33S(N)(-V)	✓	✓	✓	10 MHz to 33 GHz
R&S NRP33T(N)	✓	✓	✓	10 MHz to 33 GHz
R&S NRP-Z31	✓	✓	✓	10 MHz to 33 GHz
R&S NRP-Z37	✓	✓	✓	DC to 26.5 GHz
R&S NRP-Z52 (02, 62)	✓	✓	✓	10 MHz to 33 GHz
R&S NRP-Z52 (18)	✓	✓	✓	10 MHz to 18 GHz

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRV-Z6	✓	✓	✓	50 MHz to 26.5 GHz
R&S NRV-Z52	✓	✓	✓	10 MHz to 26.5 GHz

Table 5-4: Power sensors supported by the R&amp;S NRPC40 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRP40P	✓	✓	✓	50 MHz to 40 GHz
R&S NRP40S(N)	✓	✓	✓	50 MHz to 40 GHz
R&S NRP40T(N)	✓	✓	✓	10 MHz to 40 GHz
R&S NRP-Z41	✓	✓	✓	50 MHz to 40 GHz
R&S NRP-Z55	✓	✓	✓	10 MHz to 40 GHz
R&S NRP-Z85	✓	✓	✓	50 MHz to 40 GHz
R&S NRV-Z15	✓	✓	✓	50 MHz to 40 GHz
R&S NRV-Z55	✓	✓	✓	10 MHz to 40 GHz

Table 5-5: Power sensors supported by the R&amp;S NRPC50 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRP50P	✓	✓	✓	50 MHz to 50 GHz
R&S NRP50S(N)	✓	✓	✓	50 MHz to 50 GHz
R&S NRP50T(N)	✓	✓	✓	10 MHz to 50 GHz
R&S NRP-Z61	✓	✓	✓	50 MHz to 50 GHz
R&S NRP-Z56	✓	✓	✓	10 MHz to 50 GHz
R&S NRP-Z86 (40)	✓	✓	✓	50 MHz to 40 GHz
R&S NRP-Z86 (44)	✓	✓	✓	50 MHz to 44 GHz

Table 5-6: Power sensors supported by the R&amp;S NRPC67 calibration kit

Power sensor	Absolute accuracy		Gamma correction is mandatory	Frequency range, DUT (generator)
	Adjustment	Check		
R&S NRP67S(N)(-V)	✓	✓	✓	50 MHz to 67 GHz
R&S NRP67T(N)	✓	✓	✓	10 MHz to 67 GHz
R&S NRP-Z57	✓	✓	✓	10 MHz to 67 GHz

### 5.1.2 Calibration of linearity with R&S NRPC-LS standard

The R&S NRPC-LS calibration kit allows the check of almost all R&S power sensors at a calibration frequency of 1 GHz, see [Table 5-1](#) to [Table 5-6](#).

Most power sensors are only checked, but cannot be adjusted. For the wideband sensors R&S NRP18/40/50P and R&S NRP-Z81/85/86, you can also perform an adjustment.

Calibration of linearity with the R&S NRPC-LS calibration kit is not supported for R&S URV5-Z2 (55, 56), R&S URV5-Z4 (55, 56) and R&S URV5-Z7.

## 5.2 Controller

The entire calibration procedure is remote-controlled from a PC.

### Hardware requirements

- The hardware requirements such as clock frequency, RAM, hard disk space are not critical.
- National Instruments IEC/IEEE bus interface, which can run under the installed operating system and act as the interface to the instruments.  
Before using the calibration kit for the first time, test the installation of the IEC/IEEE bus card with the tools supplied by the manufacturer (ibconf, ibdiag, etc.).

### Software requirements

- Operating system must be Microsoft Windows® 10 or later.
- R&S Recal+ software, see [Section 2.1.7, "R&S Recal+ calibration software"](#), on page 11.
- R&S NRP-Toolkit software, see [Section 5.2.1, "R&S NRP-Toolkit"](#), on page 26.

### 5.2.1 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, sensor modules and power standards.

Windows needs the drivers for numbering purposes. Install the R&S NRP-Toolkit software before you connect a sensor for the first time.

### 5.2.1.1 Versions and downloads

The R&S NRP-Toolkit is available for:

- Microsoft Windows® operating system, as listed in [Section 5.2.1.2, "System requirements"](#), on page 27
- macOS

The latest versions for Windows and macOS are available at:

[www.rohde-schwarz.com/software/nrpc](http://www.rohde-schwarz.com/software/nrpc)

To obtain an R&S NRP-Toolkit for other operating systems, contact the Rohde & Schwarz customer support, see [Section 12.5, "Contacting customer support"](#), on page 99.

### 5.2.1.2 System requirements

Hardware requirements:

- Desktop computer or laptop

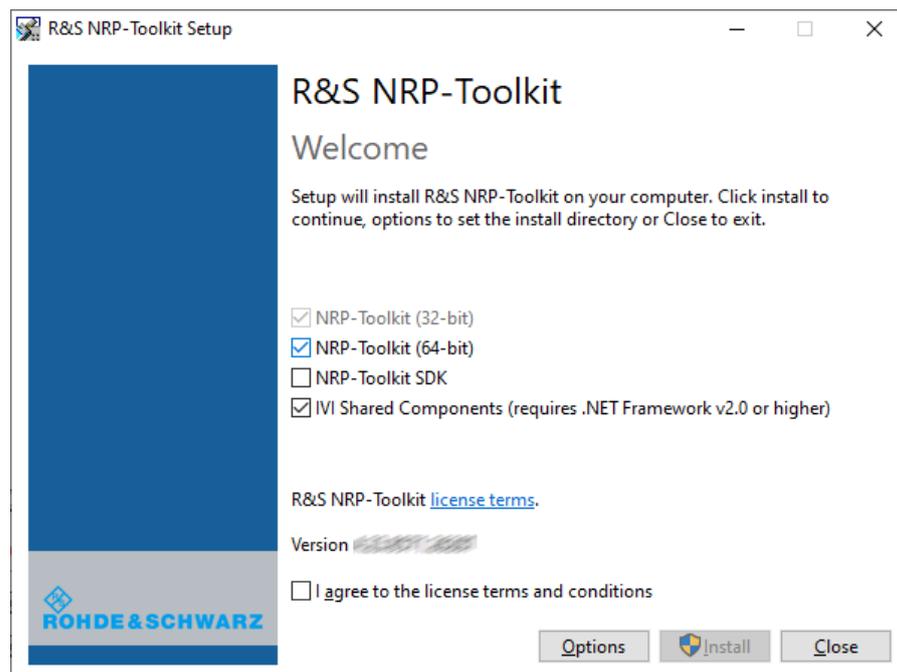
For supported Microsoft Windows versions, see the release notes.

### 5.2.1.3 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 packages that you want to install.
  - "IVI Shared Components"  
Installs the USBTMC driver. Enabled by default because the installation is recommended.



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 for Windows

Access: "Start" > "NRP-Toolkit"

The components of the R&S NRP-Toolkit depend on the operating system. The following tools are part of the R&S NRP-Toolkit for Windows.

#### Firmware Update

Installs new firmware on the sensor.

See [Section 11, "Firmware update"](#), on page 92.

### 5.2.2 Optional software

The R&S ZVX\_RECAL is separate program module of the R&S Recal+ calibration software that supports program-controlled reflection measurements together with selected network analyzers from Rohde & Schwarz. The R&S ZVX\_RECAL program module is available on the internet at:

[www.rohde-schwarz.com/software/nrpc](http://www.rohde-schwarz.com/software/nrpc)

## 5.3 Additional measurement equipment

In addition to the [Controller](#), further measurement equipment is required that is not included in the calibration kit delivery.

- [R&S NRP-ZK6, R&S NRP-ZK8 interface cable](#)..... 29
- [R&S NRX power meter](#)..... 29
- [Generators for calibration of absolute accuracy](#).....29
- [Generators for calibration of linearity](#)..... 31
- [Vector network analyzers for calibration of matching](#).....31

### 5.3.1 R&S NRP-ZK6, R&S NRP-ZK8 interface cable

For the NRP power sensors, an R&S NRP-ZK6 or R&S NRP-ZK8 interface cable is mandatory. The interface cables are available in different lengths.

For the R&S NRPC-LS, an R&S NRP-ZK8 interface cable is mandatory.

### 5.3.2 R&S NRX power meter

#### Hardware requirements

The R&S NRX must have the R&S NRX-B1 option, a 50 MHz/1 GHz sensor check source, so that a quick check of the sensors can be performed before calibration is started.

#### Firmware requirements

In order for the R&S Recal+ calibration software to function properly, the firmware version must be equal or higher than 02.31.

*Table 5-7: Required options for the R&S NRX power meter*

Short name	Long name
R&S NRX-B1	Sensor check source
R&S NRX-K2	Second measurement channel
R&S NRX-B4	Third and fourth sensor connector
R&S NRX-B8	GPIO/IEEE-488 interface

### 5.3.3 Generators for calibration of absolute accuracy

The required characteristics depend on the frequency measurement range and the power measurement range of the DUT, see [Table 5-1](#) to [Table 5-6](#). The generator must cover the entire frequency range. [Table 5-8](#) shows a selection of generators from the current Rohde & Schwarz product line that are recommended for operation of the

R&S NRPC calibration kit. This selection makes it possible to cover a wide frequency range with only a few types.

Supported generators in the current R&S product range:

- R&S SMA100B  
The required options are listed in [Table 5-8](#).
- R&S SMB100A  
The required options are listed in [Table 5-9](#).



We recommend the R&S SMA100B generator with the R&S SMA100B-B120 option since it can be used for calibration of absolute accuracy and linearity.

Older generators supported by the R&S Recal+ software are listed in [Table 5-10](#).

**Table 5-8: Required R&S SMA100B options**

Required options	f range, DUT					
	≥ 8 kHz to ≤ 6 GHz	≥ 8 kHz to ≤ 18 GHz	≥ 10 MHz to ≤ 18 GHz	≥ 10 MHz to ≤ 40 GHz	≥ 10 MHz to ≤ 50 GHz	≥ 10 MHz to ≤ 67 GHz
R&S SMAB-B106 R&S SMAB-K31 * R&S SMAB-B32 *	✓					
R&S SMAB-B120 R&S SMAB-K33 R&S SMAB-B34 *	✓	✓	✓			
R&S SMAB-B140	✓	✓	✓	✓		
R&S SMAB-B150 R&S SMAB-B37	✓	✓	✓	✓	✓	
R&S SMAB-B167 R&S SMAB-B39 R&S SMAB-K40	✓	✓	✓	✓	✓	✓

\* The "high output power" (R&S SMAB-K31, R&S SMAB-K33) and "ultra high output power" (R&S SMAB-B32, R&S SMAB-B34) options are only necessary for calibration of the linearity. We recommended selecting this option.

**Table 5-9: Required R&S SMB100A options**

Required options	f range, DUT					
	≥ 8 kHz to ≤ 6 GHz	≥ 8 kHz to ≤ 18 GHz	≥ 10 MHz to ≤ 18 GHz	≥ 10 MHz to ≤ 40 GHz	≥ 10 MHz to ≤ 50 GHz	≥ 10 MHz to ≤ 67 GHz
R&S SMB-B120 R&S SMB-B31 **			✓			
R&S SMB-B140 R&S SMBB-B32			✓	✓		

\*\* The R&S SMB-B31 option is necessary only for calibration of the R&S NRV-Z53/54 power sensors.

Table 5-10: Supported generators that are discontinued

Generator	Required options	f range, DUT					
		≥ 9 kHz to ≤ 3 GHz	≥ 9 kHz to ≤ 6 GHz	≥ 10 MHz to ≤ 18 GHz	≥ 10 MHz to ≤ 26.5 GHz	≥ 10 MHz to ≤ 33 GHz	≥ 10 MHz to ≤ 40 GHz
R&S SML03 R&S SMV03		✓					
R&S SME06 R&S SMT06		✓	✓				
R&S SMB100A	R&S SMB100A-B106	✓	✓				
R&S SMR20				✓			
R&S SMR27/30				✓	(✓)		
R&S SMR40				✓	(✓)		(✓) *
R&S SMP02/22				✓			
R&S SMP03				✓	✓		
R&S SMP04				✓	✓	✓	(✓) *
R&S SMF100A	R&S SMF-B144, R&S SMF-B2, R&S SMF-B27			✓	✓	✓	
R&S SMF100A	R&S SMF-B34			✓	✓	✓	

\* Only suitable for calibration of R&S NRV-Z6/15.

### 5.3.4 Generators for calibration of linearity

The R&S SMA100B generator is mandatory for linearity measurements with R&S Recal+ and the R&S NRPC-LS calibration kit. All power sensors from Rohde & Schwarz are measured at a calibration frequency of 1 GHz. See [Table 5-1](#) to [Table 5-6](#).

The R&S SMA100B with frequency option up to 20 GHz and with the "High output power" and "Ultra high output power" options is excellent suitable for calibration of linearity. See [Table 5-8](#).

### 5.3.5 Vector network analyzers for calibration of matching

The required characteristics are focused primarily on the frequency range and connector used by the DUT, see [Table 5-1](#) to [Table 5-6](#). Its lower frequency limit is less important since the power sensors from Rohde & Schwarz do not exhibit any significant changes in the matching at lower frequencies. Accordingly, a standard lower frequency limit of 10 MHz can be assumed when selecting an appropriate analyzer.

[Table 5-11](#) lists a group of network analyzers that are selected because you only need very few types to cover a very large frequency range. Only these analyzers along with

the analyzers listed in [Table 5-12](#) are currently supported by the R&S Recal+ calibration software and the R&S ZVX\_RECAL program module.

Of course, it is also possible to use other network analyzers. However, you have to ensure that the appropriate frequency points are measured and the calibration results are made available in the necessary file format.

See also [Section 8.1.5, "Formatting and saving the reflection measured values"](#), on page 73.

For calibration of the supported network analyzers, the calibration kits listed in [Table 5-13](#) are recommended. For sensors with a 3.5 mm connector, the R&S ZN-Z235 standard kit with a frequency range of 26.5 GHz is not adequate. Instead, use the R&S ZV-Z235E extended kit that is specified for use up to 33 GHz.



For the sake of traceability and higher accuracy, the accredited calibration is recommended at the laboratory D-K-15195-01-01 operated by Rohde & Schwarz.

The accredited calibration is included only for the R&S ZV-Z235E and R&S NRPC calibration kits. For all other products, you have to order it separately.

**Table 5-11: Supported R&S network analyzers**

Network analyzer	f range, DUT					
	≥ 8 kHz to ≤ 6 GHz	≥ 8 kHz to ≤ 18 GHz	≥ 10 MHz to ≤ 18 GHz	≥ 10 MHz to ≤ 40 GHz	≥ 10 MHz to ≤ 50 GHz	≥ 10 MHz to ≤ 67 GHz
R&S ZNB8	✓ *	✓ **				
R&S ZNB20		✓ **	✓			
R&S ZNB43		✓ **	✓	✓		
R&S ZNA26		✓ **	✓			
R&S ZNA43		✓ **	✓	✓		
R&S ZNA50		✓ **	✓	✓	✓	
R&S ZNA67		✓ **	✓	✓	✓	✓

\* A vector network analyzer with a lower frequency limit of 9 kHz is sufficient. The calibration software extrapolates the 8 kHz matching value.

\*\* Frequency range is only supported by a combination of two vector network analyzers. One for the lower frequency range (e.g. R&S ZNB8) and one for the upper frequency range (e.g. R&S ZNB20).

**Table 5-12: Supported R&S network analyzers that are discontinued**

Network analyzer	R&S NRPC calibration kit used for power calibration				
	R&S NRPC18	R&S NRPC33	R&S NRPC40	R&S NRPC50	R&S NRPC67
R&S ZVM	✓				
R&S ZVB20	✓				
R&S ZVK	✓	✓	✓		
R&S ZVA24	✓				

Network analyzer	R&S NRPC calibration kit used for power calibration				
	R&S NRPC18	R&S NRPC33	R&S NRPC40	R&S NRPC50	R&S NRPC67
R&S ZVA40	✓	✓	✓		
R&S ZVA50	✓	✓	✓	✓	
R&S ZVA67	✓	✓	✓	✓	✓

Table 5-13: Recommended calibration kits for network analyzers

Connector	N-50 Ω	3.5 mm	2.92 mm	2.4 mm	1.85 mm
Frequency range	DC to 18 GHz	DC to 33 GHz	DC to 40 GHz	DC to 50 GHz	DC to 67 GHz
Type	R&S ZV-Z270	R&S ZV-Z235E	R&S ZN-Z229	R&S ZN-Z224	R&S ZN-Z218

## 5.4 Power calibration setup for R&S power sensors

This section describes the measurement equipment and setup for power calibration of NRP, R&S NRP-Z and R&S FSH-Z1/18 power sensors.

For information on power calibration of discontinued power sensor families, see [Section 9.1, "Power calibration of R&S NRV-Z and R&S URV5-Z sensors"](#), on page 86.

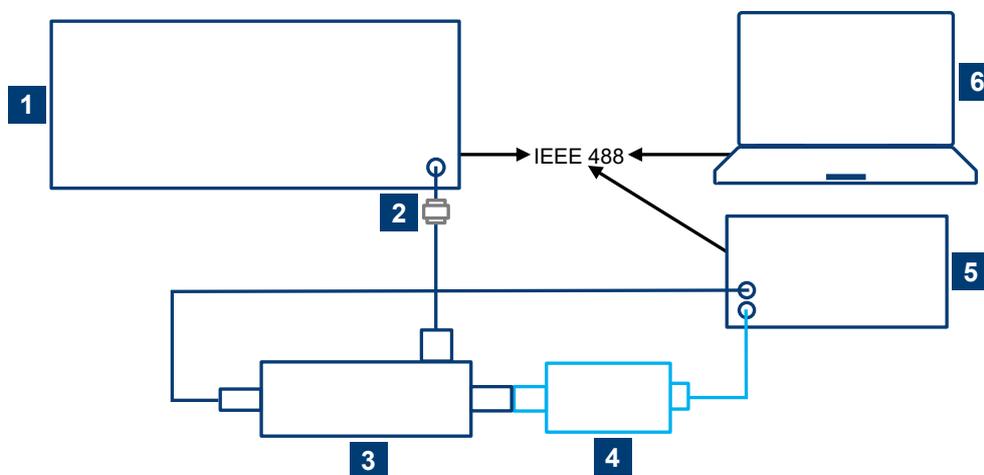


Figure 5-1: Setup for power calibration of R&S power sensors

- 1 = Generator
- 2 = Depending on the generator used, an adapter for connecting the RF cable can be required.
- 3 = R&S NRPC
- 4 = DUT
- 5 = R&S NRX power meter; for connecting NRP power sensors and R&S NRPC power standard, use an R&S NRP-ZK6 or R&S NRP-ZK8 interface cable.
- 6 = Controller, a computer with R&S Recal+ installed

Generator, power meter and computer are connected via their IEEE-488 interfaces.

**Additional requirements for specific sensor types**

- R&S FSH-Z1/18 power sensors:  
An adapter cable is required for connecting the power sensor to the R&S NRX.
- R&S NRPxA(N) average power sensors:  
An R&S SMA100B generator is required (covers the entire frequency range of 8 kHz up to 18 GHz).
- R&S NRP18S-xx power sensors: Remove the attenuator before performing the calibration.

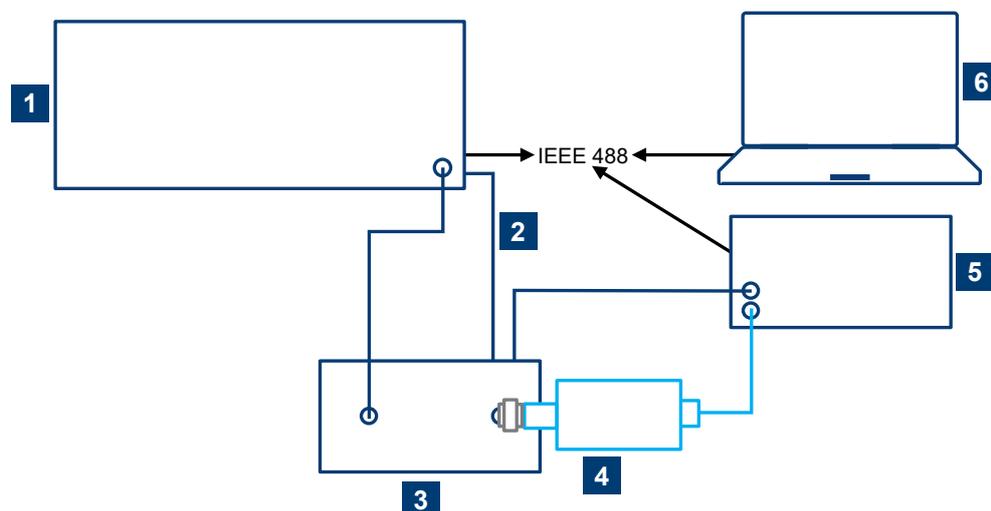
For details on the measurement equipment, see:

- [Section 5.1, "Supported R&S power sensors"](#), on page 23
- [Section 5.2, "Controller"](#), on page 26
- [Section 5.3.2, "R&S NRX power meter"](#), on page 29
- [Section 5.3.3, "Generators for calibration of absolute accuracy"](#), on page 29
- [Section 5.3.4, "Generators for calibration of linearity"](#), on page 31
- [Section 5.3.5, "Vector network analyzers for calibration of matching"](#), on page 31

## 5.5 Linearity calibration setup for R&S power sensors

This section describes the measurement equipment and setup for linearity calibration of NRP, R&S NRP-Z and R&S FSH-Z1/18 power sensors.

For information on power calibration of discontinued power sensor families, see [Section 9.2, "Linearity calibration of R&S NRV-Z and R&S URV5-Z sensors"](#), on page 88.



**Figure 5-2: Setup for linearity calibration of R&S power sensors**

- 1 = R&S SMA100B generator  
 2 = 10 MHz reference; connect the internal reference oscillator of the generator to the reference clock of the R&S NRPC-LS.  
 3 = R&S NRPC-LS

## Linearity calibration setup for R&amp;S power sensors

- 4 = DUT; depending on the DUT used, an adapter for connecting to the test port of the R&S NRPC-LS can be required. See [Table 5-14](#).
- 5 = R&S NRX power meter; for connecting the NRP power sensors, use an R&S NRP-ZK6 or R&S NRP-ZK8 interface cable; for connecting the R&S NRPC-LS power standard, use an R&S NRP-ZK8 interface cable.
- 6 = Controller, a computer with R&S Recal+ installed

**Table 5-14: Adapter for connecting the DUT to the R&S NRPC-LS**

Connector of DUT	Calibration kit	Adapter included in calibration kit
3.5 mm	R&S NRPC33	N (male) to SMA (female)
2.92 mm	R&S NRPC40	N (male) to SMA (female)
2.4 mm	R&S NRPC50	N (male) to PC2.4 (female)
1.85 mm	R&S NRPC67	N (male) to PC2.4 (female)

For details on the measurement equipment, see:

- [Section 5.1, "Supported R&S power sensors"](#), on page 23
- [Section 5.2, "Controller"](#), on page 26
- [Section 5.3.2, "R&S NRX power meter"](#), on page 29
- [Section 5.3.3, "Generators for calibration of absolute accuracy"](#), on page 29
- [Section 5.3.4, "Generators for calibration of linearity"](#), on page 31
- [Section 5.3.5, "Vector network analyzers for calibration of matching"](#), on page 31

## 6 Sensor calibration

### 6.1 Preparing

The installation of the R&S Recal+ calibration software and the R&S ZVX\_RECAL program module is described in the release notes, see also [Section 2.1.7, "R&S Recal+ calibration software"](#), on page 11.

#### 6.1.1 Starting the calibration software

- ▶ To start the calibration software:
  - Double-clicking the following icon on the desktop:



- Use the Windows® search.

If R&S Recal+ is called for the first time, some variables are not yet defined. Accordingly, R&S Recal+ prompts you to enter the name and address of the calibration laboratory, initialize the measuring equipment, etc. The required steps are described in detail in the sections below. All entries are saved in the `recal32.ini` initialization file and are applied automatically when R&S Recal+ is called again.

## 6.1.2 Entering the name and address of the calibration laboratory

Figure 6-1: General Sensor Data dialog

Access: "Options" menu > "General Sensor Data"

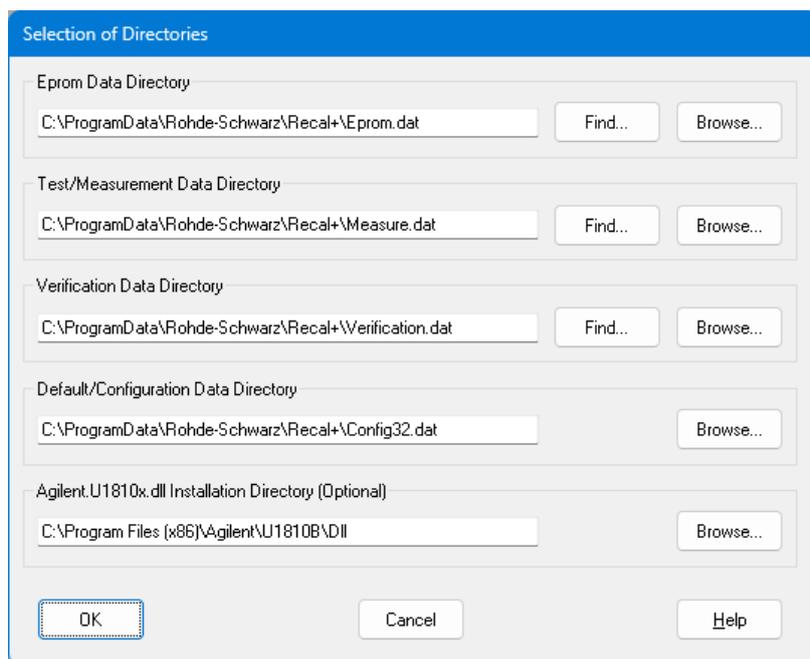
### To enter the data in the "General Sensor Data" dialog

1. "Calibration Laboratory": Name of the calibration laboratory, max. 20 characters.
2. "Person Responsible": Name of the person carrying out the calibration: Up to 5 persons, max. 20 characters per entry.
3. To add a new person:
  - a) Mark the name currently displayed.
  - b) Overwrite the name.
  - c) Confirm with the [Enter] key.
4. To delete individual names:
  - a) Mark the name currently displayed.
  - b) Click "Delete".
5. "Company & Address": Name of the company to which the calibration laboratory belongs, max. 40 characters; company address, max. 40 characters.

For subsequent modifications, under "Options", use the "General Sensor Data..." dialog.

## 6.1.3 Defining directories

After correct installation, the following subdirectories are created automatically.



**Figure 6-2: Selection of Directories dialog**

Access: "Options" menu > "Directories"

1. If the directories are suitable for you, click "OK".
2. If you want to select another subdirectory, click "Browse".

### 6.1.4 Initializing the measuring equipment

Initialize all remote-controlled instruments before any measurements are made. These instruments are:

- R&S NRX
- Generator for calibration of absolute accuracy
- Generator for linearization
- Vector network analyzer

#### To prepare to initialize the measuring equipment

1. Connect the instruments to the controller using the IEC/IEEE bus.
2. Switch on the instruments.

#### 6.1.4.1 Configuring power meters with the R&S NRPC calibration kit

Operating an R&S NRPC calibration kit requires at least one R&S NRX base unit to which the power standards and R&S power sensors can be connected. For calibrating sensors of the R&S NRV-Z and R&S URV5-Z families, an R&S NRVD base unit is also

necessary. Overall, two base units can be controlled. Connect the DUT to channel A or channel B of the basic power meter. You can connect the power standards to any of the available channels. [Table 6-1](#) shows the possible combinations:

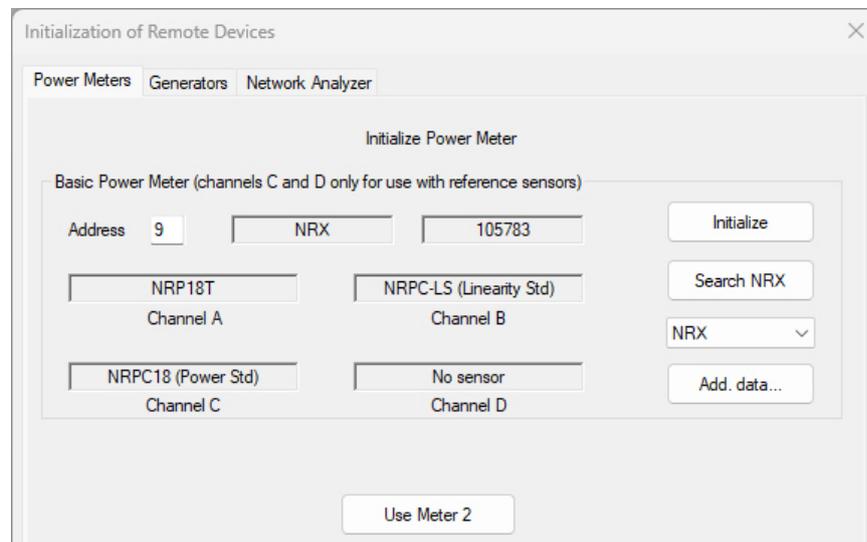
**Table 6-1: Basic power meters configuration**

Basic power meter			Meter 2 **
R&S NRX			R&S NRX
Channel A (B)	Channel B (A)	Channel C / D *	Channel A / B / C / D *
DUT (R&S power sensor)	R&S NRPC	R&S NRPC	R&S NRPC
* Availability depends on the R&S NRX configuration.			
** Necessary if more power standards from the R&S NRPC calibration kits are to be connected.			

Regardless of the selected combination, the R&S NRPC reinitializes before calibrating a sensor. After clicking "Add data...", information is provided for each R&S NRPC that was used in the last calibration. After changing the power standard, this information is only updated after starting a new measurement ()

#### 6.1.4.2 Initializing the R&S NRX

Access: "Options" menu > "Remote Devices" > "Initialization of Remote Devices" dialog



1. In the "Initialization of Remote Devices" dialog, select the "Meter" tab.
2. Under "Basic Power Meter", click "Search NRX".

The calibration software now searches for an R&S NRX from among the instruments that are connected to the IEC/IEEE bus. If the search is successful, the address of the device is displayed in the address field. Click "Search NRX" again if a second R&S NRX was found that you do not want to use as the basic power meter.

3. Click "Initialize".

The calibration software initializes the R&S NRX that was found at the specified address.

4. If a second R&S NRX is available, click "Use Meter 2".
5. Proceed as for the first power meter.

### 6.1.4.3 Initializing generators

Access: "Options" menu > "Remote Devices" > "Initialization of Remote Devices" dialog

1. In the "Initialization of Remote Devices" dialog, select the "Generator" tab.

2. Under "Generator (for absolute accuracy measurement)", initialize the generator for the absolute accuracy measurement:
  - a) Click "Search Generator".
  - b) Click "Initialize".
  - c) Click "Add data..." to enter the calibration expiry date and the calibration certificate number.  
For some older generators, also enter the serial number.

**Note:** If multiple generators for calibrating absolute accuracy are connected at the same time, e.g. an R&S SMB100A-B106 and an R&S SMF100A-B144, only one of the instruments can be initialized. If the generator is replaced, reinitialization is necessary. The previously assigned IEC/IEEE bus address is automatically suggested.

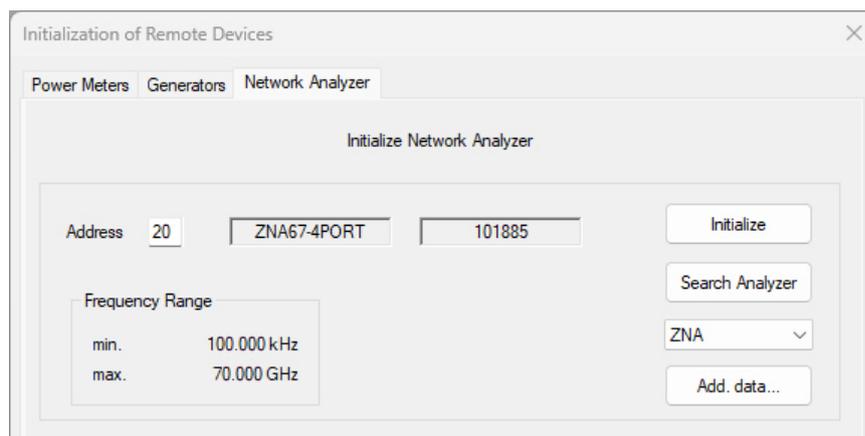
3. Under "Generator (for linearity measurement)", initialize the generator for the linearity measurement:
  - a) Click "Search Generator".
  - b) Click "Initialize".
  - c) Click "Add data..." to enter the calibration expiry date and the calibration certificate number.
4. Click "Close".

All entries are saved in the `recal32.ini` file to be used by R&S Recal+ in the next session.

**Tip:** For further modifications, use the "Remote Devices" dialog in the "Options" menu.

#### 6.1.4.4 Initializing network analyzers

Access: "Options" menu > "Remote Devices" > "Initialization of Remote Devices" dialog



The "Network Analyzer" tab is only available if the R&S ZVX\_RECAL program module is installed.

1. In the "Initialization of Remote Devices" dialog, select the "Network Analyzer" tab.
2. Select the type that you want to use.
3. Initialize the vector network analyzer:
  - a) Click "Search Analyzer".
  - b) Click "Initialize".
  - c) Click "Add data..." to enter the calibration expiry date and the calibration certificate number.
4. Click "Close".

All entries are saved in the `recal32.ini` file to be used by R&S Recal+ in the next session.

## 6.2 Performing the calibration

A power or voltage sensor is calibrated in several phases that are shown in [Table 6-2](#) in the appropriate order. After the incoming inspection, calibration of the incoming condition is performed for the matching, absolute accuracy and linearity. The R&S Recal+ software checks the resulting data for compliance with the appropriate tolerance limits. For sensors whose correction factor set can be refreshed, this data forms the basis for a new correction factor set.

As the next step, generate an initial report with the "Calibration Report (Incoming)". As a rule, prepare this documentation for all sensors whose correction factor set (EPROM file) cannot be overwritten, e.g. for all R&S URV5-Z voltage sensors. For these sensors, the calibration process is also generally complete once the "Calibration Report (Incoming)" is generated. Send the DUTs that exceed the tolerance limits to the manufacturer for repair.

For most sensors, the correction factor set can be overwritten. Then reporting of the incoming condition is necessary only if the DUT exhibited non-compliance with the relevant specifications. If the measurement errors are so large that the device is clearly damaged or subject to unnatural premature aging, send the DUT for repair. Otherwise, you can overwrite the correction factor set.

The new correction factor set is obtained from the measurement results gathered during the incoming test and the saved correction factors. Overwriting the data memory with this data ensures that the DUT uncertainty during subsequent usage is only slightly larger than the uncertainty of the calibration. To verify this fact, test the absolute accuracy once again after the data memory is refreshed. For some sensors, this check also includes a check of the linearity with the modified correction factors. The measurement results are documented with the "Calibration Report". Archiving of all relevant data marks the end of the calibration cycle.

The sequence of calibration steps suggested in [Table 6-2](#) is not mandatory when using the R&S Recal+ calibration software that means you are free to create a calibration cycle that best meets your requirements. For example, you can choose to omit documentation, repeat measurements several times or omit individual calibration steps, e.g. linearization or matching. It is not possible to select meaningless combinations such as

calculating a new EPROM file without measurement data. The following sections explain each of the calibration steps in detail.

**Table 6-2: Overview of a complete calibration cycle**

Phase		Section	Comments
I	Preparation	Section 6.2.1, "Initial checks", on page 44	
II	Calibration on delivery	Section 6.2.2, "Checking the matching", on page 45	
		Section 6.2.3, "Checking the linearity", on page 46	
		Section 6.2.4, "Checking the absolute accuracy", on page 48	
		Section 8.2, "S-parameter file for sensors with attenuators", on page 78	If relevant, measuring the attenuator on ext. meas. setup, only for the R&S NRP-Z22/23/24/92).
III	Documentation of calibration	Section 6.4, "Generating the calibration report", on page 53	Only sensors whose correction factor set can be overwritten.
IV	Refreshing the data memory	Section 6.4.2, "Calculating a new EPROM file", on page 55 Section 6.4.3, "Overwriting the data memory of a sensor with flash EPROM", on page 56	
V	Outgoing calibration	Section 6.2.4, "Checking the absolute accuracy", on page 48 Section 6.2.3, "Checking the linearity", on page 46	
VI	Documentation of calibration	Section 6.4, "Generating the calibration report", on page 53	
VII	Archiving	Section 6.5, "Archiving", on page 58	



- The recommended ambient temperature during calibration is 23 °C. Deviations of  $\pm 3$  °C maximum are permissible, but avoid them, if possible. Larger temperature deviations can cause the measurement uncertainties specified for the R&S NRPC calibration kits to be exceeded.
- Allow the test setup to warm up for at least one hour before calibration.
- After the power standard and linearity standard are connected to the base unit, allow them to warm up for at least one hour.
- Allow the R&S URV5-Z and R&S NRV sensors a few minutes to obtain normal operating temperature after connecting to the R&S NRVD base unit. Due to their higher self-warming, the R&S power sensors require about 30 minutes to warm up on an R&S NRX base unit or computer.

### 6.2.1 Initial checks

To prevent measurement errors during calibration, inspect the DUT closely and perform a few simple tests. This approach also prevents any potential damage to the calibration kit.

#### To inspect the DUT

1. Inspect the sensor cable for external damage.
2. Verify that the cable is properly connected to the sensor and data memory.
3. Clean the RF connectors.
4. Check the position of the inner conductor to the reference plane of the RF connector.
5. Connect the DUT to a suitable base unit.
6. Connect the RF interface of the DUT to the test generator.
7. Make sure that there is a good connection between the connector and the sensor casing.
8. Power on the test generator. The power reading must be stable even if the sensor cable is moved or the sensor casing is bent or twisted slightly.

#### To perform a self-test

Applies only for the R&S power sensors.

1. Start the R&S Recal+ software.
2. Initialize the base unit as a "basic power meter".
3. In the toolbar, click  to open the "Measurement with Recal+" dialog.
4. Select the "NRP Sensor Test" tab.
5. Click "Execute Test" to perform the built-in self-test for the selected DUT.

The test results consist of a global "SUCCESSFUL" or "FAILED" assessment along with individual test results.

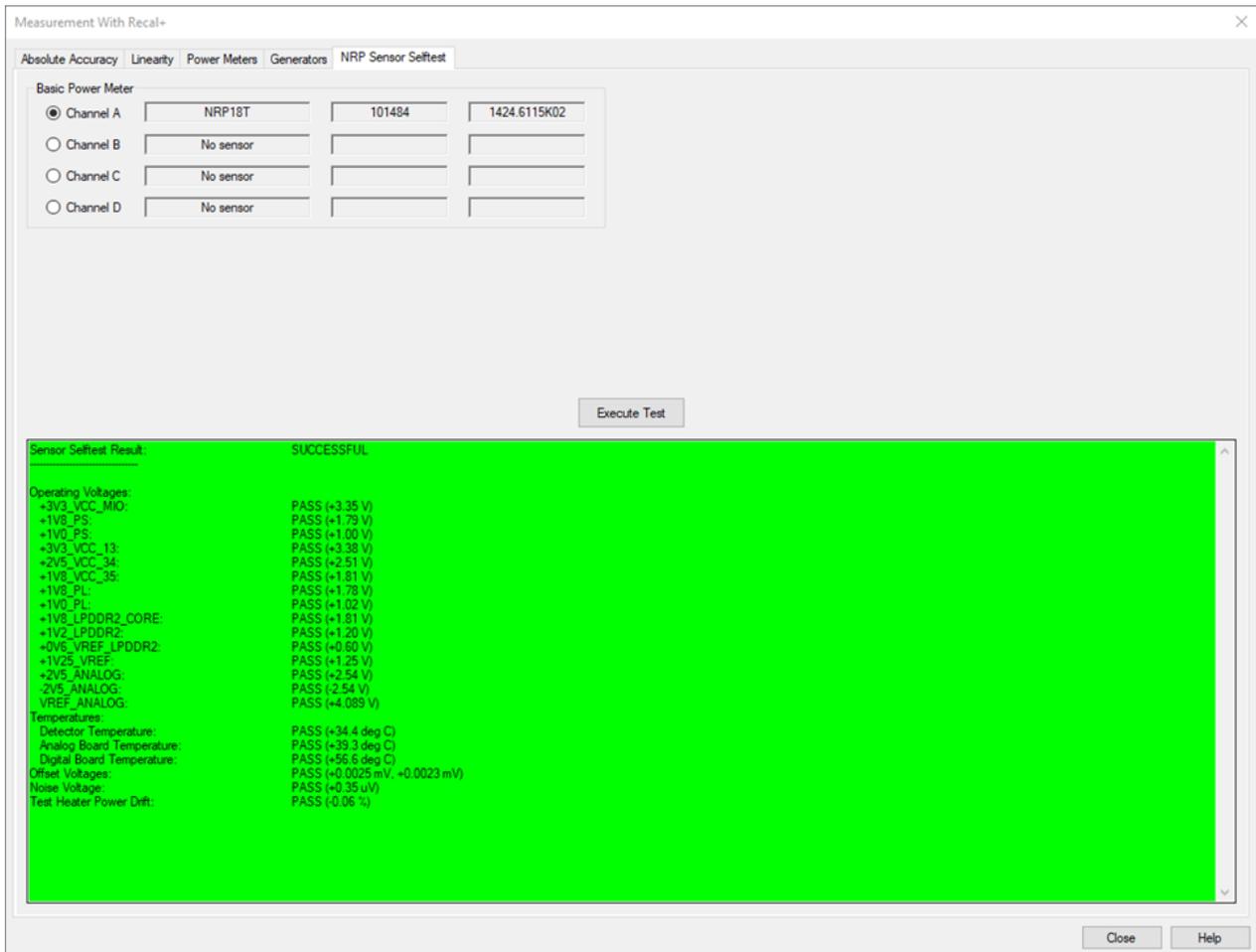


Figure 6-3: NRP Sensor Test tab with measurement results

## 6.2.2 Checking the matching

The matching of the DUT is measured with the aid of a vector network analyzer. The required steps are described in [Section 8.1.4, "Configuring the network analyzer"](#), on page 71.

If it is necessary to measure the absolute accuracy with gamma correction, the reflection data of the DUT must be determined beforehand and saved in the `... \recal\measure.dat` file. Otherwise, you cannot enable the gamma correction function.

## 6.2.3 Checking the linearity

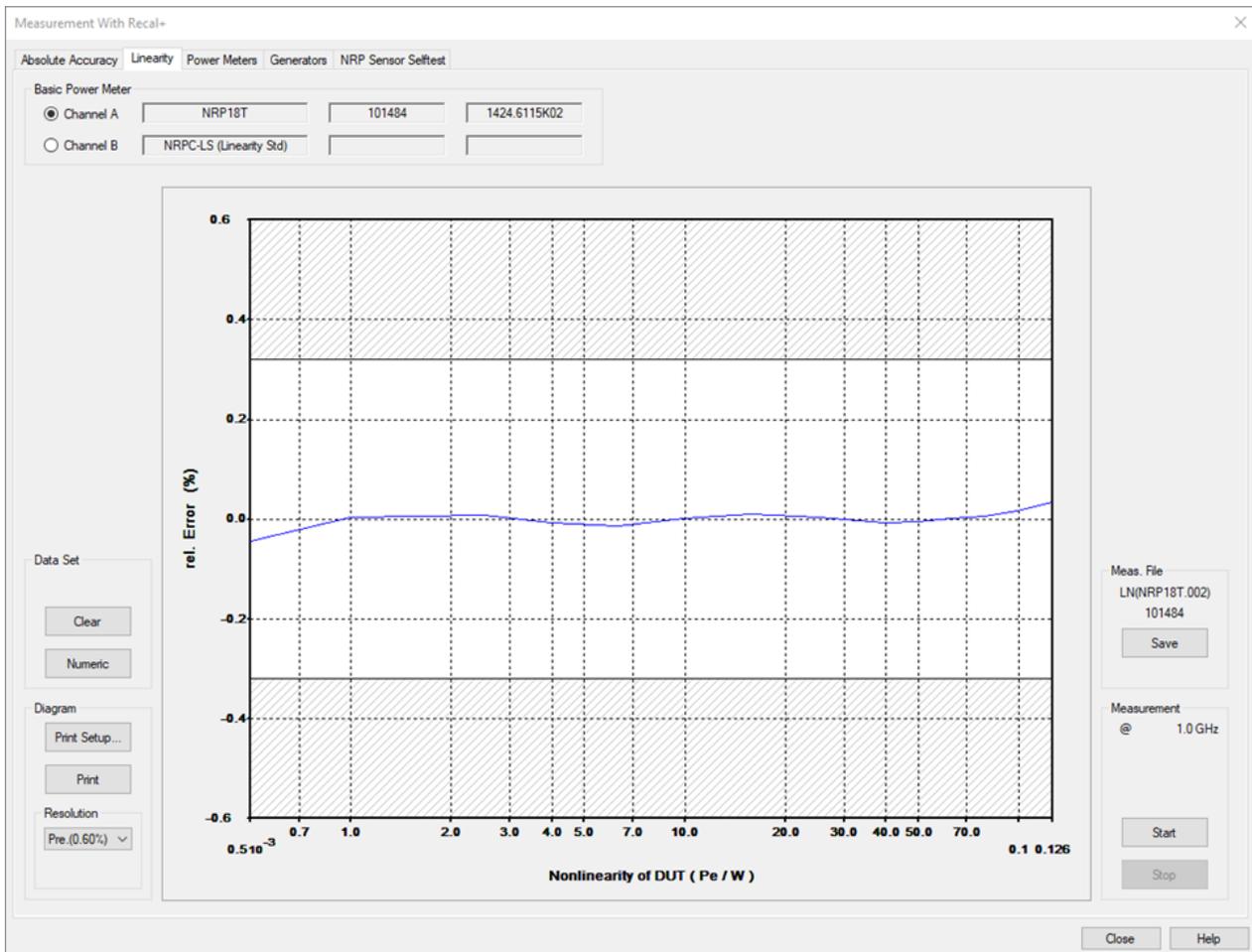


Figure 6-4: Linearity tab at the end of a measurement procedure

Access:  in the toolbar > "Measurement with Recal+" dialog

### To check the linearity

1. Prepare the appropriate test setup for the sensor as described in [Section 5.5, "Linearity calibration setup for R&S power sensors"](#), on page 34.
2. Initialize any instruments that have not yet been initialized ("Meter" or "Generator" tab).
3. In the toolbar, click .
4. Select the "Linearity" tab.
5. Select the graphics or numerical display mode for measured values. See also ["Displaying the measurement results on screen"](#) on page 50.
6. Click "Start".

The linearity measurement starts. Starting from the specific reference power of the sensor, the power applied to the DUT is increased until the nominal power is reached. The relative changes in power measured by the DUT (voltage changes for the R&S URV5-Z sensors) are compared to the changes measured by the linearity standard. They are output as linearity errors in %.

**Note:** During the linearity measurement on R&S power sensors, the R&S NRX base unit can generate an overload message at the last level step. It is safe to ignore this message.

7. Check whether the measured errors are within the tolerance band in the graphical display.
8. Click "Save" to save the measurement results in a file with the specified filename.

**Note:** Only saved measurement results can be output in the calibration report and used when the data memory contents are recalculated.

### Repeating incorrect measurements

Occasionally, you have to repeat a measurement because, for example, the RF connector of the sensor is loose.

- ▶ Click "Start" to restart the measurement.

### Displaying the measurement results on screen

The linearity errors of the DUT can be displayed in graphical or list format.

- ▶ Click "Numeric (Diagram)" to toggle between the two modes.
- ▶ Click "Print" to print the graphical displays.

### Graphical display (nonlinearity of DUT)

The linearity errors of the DUT are plotted as the "Rel. error (%)" together with the tolerance band versus the input power " $P_{in}$ " or the input voltage " $V_{in}$ ". Generally, it is safe to assume that a sensor that exceeds the tolerance limits is defective and must be sent back to Rohde & Schwarz central service for repair. Send all sensors for repair for which a correction of the linearity is not possible, see [Table 5-1](#) to [Table 5-6](#). The measurement points at which the tolerance limits are exceeded are indicated by an asterisk (\*) in the calibration report.

You can set the vertical resolution of the diagram to a customized scaling, see ["To customize the scaling"](#) on page 47, or select one of the following four settings in the "Resolution" list: "Pre. (x %)", "Fine (1 %)", "Coarse (50 %)", "y %". "Pre (x %)" yields the optimum resolution for the sensor (Preset). "y %" is the customized scaling last selected.

### To customize the scaling

1. Place the mouse cursor on the label for the highest value on the scale.  
The  symbol appears.

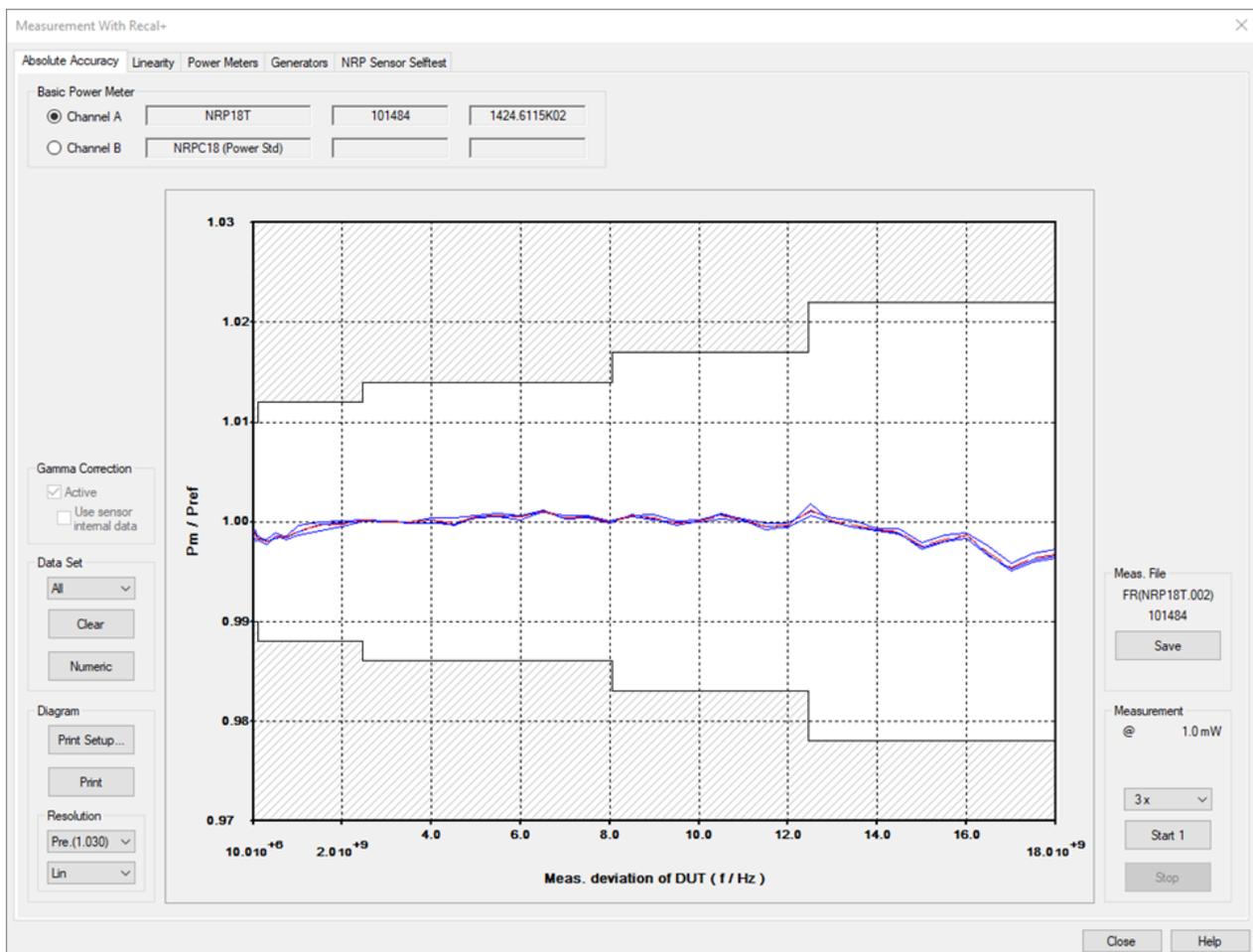
2. Double-click and enter the number needed for this maximum value.
3. To enlarge the graphical display:
  - a) Place the mouse cursor over the diagram. The  symbol appears.
  - b) Double-click.

**Tip:** When in zoom mode, you can display the context menu without having to return to the normal display ([Esc] key).

### Outputting numeric measured values

The list has four columns, namely the index number of the level step ("Index"), the nominal level step ("Nom. Level" in "W" or "V"), the value measured for the DUT ("Meas. Level" in "W" or "V") and the linearity error of the DUT ("Error" in "%").

## 6.2.4 Checking the absolute accuracy



*Figure 6-5: Absolute Accuracy tab at the end of a measurement sequence*

Access:  in the toolbar > "Measurement with Recal+" dialog

### To check the absolute accuracy

For all thermal R&S power sensors and all sensors with a frequency range of more than 18 GHz, measure with gamma correction. If you measure without gamma correction, the R&S Recal+ software outputs a warning after you start the measurement. You cannot use the measurement data generated in this manner to create a correction factor set.

For the R&S URV5-Z sensors, gamma correction is not possible.

1. If you measure without gamma correction:
  - a) Determine the reflection data of the DUT beforehand.
  - b) Save the reflection data in the `... \recal\measure.dat` file.
  - c) Enable the option for gamma correction.

**Note:** You can start the measurement only if reflection data is available for the DUT in complex notation. Otherwise, an error message is displayed.
2. If you do not need gamma correction for the DUT, disable the option.
3. Prepare the test setup as shown in [Section 5.4, "Power calibration setup for R&S power sensors"](#), on page 33.
4. Initialize the instruments that have not already been initialized ("Meter" and "Generator" tabs).
5. In the toolbar, click .
6. Select the "Absolute Accuracy" tab.
7. Select the measurement channel to which the DUT is connected.
8. If you need to measure with gamma correction for the sake of accuracy, enable the corresponding option.
9. Under "Measurement", specify the number of measurement cycles ("1x", "2x", "3x", "4x"). For the initial calibration, perform at least three cycles as a basis for recalculating the correction factors. For the second calibration after the data memory has been overwritten, one measurement is usually sufficient because the measurement errors are very small.
10. Select a graphical or numeric result display. See ["Displaying the measurement results on screen"](#) on page 50.
11. Click "Start 1".

The first cycle is started. When measurements are performed with the reference attenuator, the "Attenuator" dialog appears shortly after the start. Click "OK" only if you are sure that the displayed file is the correct one for the attenuator in the measurement setup. The filename to the right of the "at" header has to be identical to the serial number of the attenuator.

Otherwise, select the appropriate file from the "file selection" list.

You can suppress the routine display of the "Attenuator" dialog by disabling "Confirm before each measurement".

If several measurement cycles are carried out, after each cycle, the R&S Recal+ software prompts you to reconnect the sensor in a modified position and continue the measurement.

12. Disconnect the RF connector.
13. Turn the sensor or attenuator by 90°, 120° or 180° depending on the number of cycles.
14. Treat the power attenuator of the R&S NRV-Z32/33/53/54 sensors as the reference attenuator.
15. Click "Ja" ("Yes").

Once the measurement sequence is completed, the averaged power or voltage ratio is displayed as a red line in the diagram.

16. Click "Save" to save the measurement results in a file with the specified filename.

**Note:** Only saved measurement results can be output in the calibration report and used when the data memory contents are recalculated.

### Repeating faulty measurements

Occasionally, you have to repeat a measurement because, for example, the RF connector of the sensor is loose.

1. Under "Data set", select the faulty cycle.
2. Click "Clear".

The associated measurement result display is removed from the diagram.

3. Click "Start" to repeat the measurement.

### Displaying the measurement results on screen

The measurement errors of the DUT can be displayed in graphical or list format.

- ▶ Select the data that you want to display:
  - Under "Data Set/Path", for R&S power sensors
  - Under "Data Set" in all other cases
- ▶ Click "Numeric (Diagram)" to toggle between the two modes.
- ▶ Click "Print" to print the graphical displays.

### Graphical display (measured deviation of DUT)

The measurement errors of the DUT are displayed together with the tolerance band as a power ratio " $P_m/P_{ref}$ " or a voltage ratio " $V_m/V_{ref}$ " (index m: DUT) versus frequency. Consider the R&S URV5-Z2/4/7 and R&S NRV-Z31/32/33 defective if the tolerance limits are exceeded, in which case you have to send them back to Rohde & Schwarz central service for repair. Otherwise, you have to decide on a case-by-case basis. Out

of tolerance conditions below 1 GHz often indicate that the sensor is defective. The measurement points at which the tolerance limits are exceeded are indicated by an asterisk (\*) in the calibration report.

You can set the graphical scale using "Lin/Log" (scale for frequency axis) and "Resolution" (vertical resolution). You can set the vertical resolution of the diagram to a customized scaling, see ["To customize the scaling"](#) on page 51, or select one of the following four settings in the "Resolution" list: "Pre. (x)", "Fine (1.05)", "Coarse (1.5)", "y". "Pre. (x)" yields the optimum resolution (Preset) for the sensor. "y" is the customized scaling last selected.

#### To customize the scaling

1. Place the mouse cursor on the label for the highest value on the scale.

The  symbol appears.

2. Double-click and enter the number needed for this maximum value.

3. To enlarge the graphical display:

- a) Place the mouse cursor over the diagram. The  symbol appears.
- b) Double-click.

**Tip:** When in zoom mode, you can display the context menu without having to return to the normal display ([Esc] key).

#### Outputting numeric measured values

The list has four columns, namely the index number ("Index") of the frequency point, the frequency ("Frequency"), the power ratio " $P_m/P_{ref}$ " or the voltage ratio " $V_m/V_{ref}$ " ("Factor") and the measured value for the power standard ("Level"). The values that are output are for the current measurement.

#### Usage of torque wrenches

All R&S NRPC calibration kits include an appropriate torque wrench for the given connector type. The torque is set to ensure a dependable connection and also to prevent wear and tear.

## 6.3 Troubleshooting measurement problems

### Start... is disabled

Possible cause: The power standard and/or the DUT are not connected to the R&S NRX or R&S NRVD.

- ▶ Check the test setup as shown in [Section 5.4, "Power calibration setup for R&S power sensors"](#), on page 33.

Possible cause: The R&S NRX, R&S NRVD, and/or generator have not been initialized.

1. Select the "Power Meters" and/or "Generators" tab.
2. Repeat the initialization. See [Section 6.1.4, "Initializing the measuring equipment"](#), on page 38.

#### **Error message at the start of or during the measurements**

"Error detected: Measurement out of tolerance ( $\pm 50\%$ ). Please check your test equipment."

Possible cause: The level on the power standard or linearity standard and/or DUT is too high or too low. You forgot to insert or remove the reference attenuator, or the power standard is not connected to the generator.

1. Check the test setup as shown in [Section 5.4, "Power calibration setup for R&S power sensors"](#), on page 33.
2. Verify the calibration kit.

#### **The measurement result spread for the cycles is too large**

Only occurs in absolute accuracy measurements.

Possible cause: The DUT, power standard or attenuator is defective.

- ▶ Verify the calibration kit.

## 6.4 Generating the calibration report

**Figure 6-6: Report Generation dialog**

Access: "Calibration" / "File" menu > "Calibration reports"

A calibration report documenting the calibration procedure can be generated at any time. It contains a cover sheet with general information, a list of the measuring equipment used, and a list of the measurement results. There are two versions of the calibration report.

The "Calibration Report (Incoming)" documents the incoming condition, and the "Calibration Report" describes the status after the data memory has been overwritten and the final control measurements have been performed. While the "Calibration Report (Incoming)" is merely a straightforward measurement report listing all measurement points, the "Calibration Report" also contains information about the saved calibration factors. We recommend generating the "Calibration Report" only if the sensor data set has been adjusted and the data memory of the sensor has been overwritten. If an adjustment is possible depends on the sensor type, see [Table 5-1](#) to [Table 5-6](#).

### To generate the calibration reports

1. In the "Report Generation" dialog, mark the measurement channel to which the calibrated sensor is connected or select the EPROM file for the sensor from the file list that is displayed, filename: ep(<sensor><serial no.>).
2. Select "Calibration Report (Incoming)" or "Calibration Report".
3. For complete documentation, fill out the "Report No." and "Customer" fields.
4. Click "OK".

The calibration report, excluding the cover sheet and the list of measuring equipment, is displayed on screen.

5. To view the complete calibration report on the screen, select the "Print Preview" dialog in the "File" menu.
6. Print the calibration report or save the calibration report in a PDF file, using a printer driver for creating PDF files.



#### **Note regarding the calibration report (incoming) for R&S power sensors and R&S NRV-Z sensors**

When the new EPROM file for the sensor has been calculated, the R&S Recal+ software saves a backup copy of the incoming calibration and the data memory contents in the `... \recal\measure.dat\income` and `... \recal\eprom.dat\income` directories. Using this data, you can output the "Calibration Report (Incoming)" at the very end of calibration. R&S Recal+ accesses the saved files and uses the data from the `... \recal\measure.dat` or `... \recal\eprom.dat` directory for the "Calibration Report (Incoming)" only if it does not find data for the sensor in the "income" sub-directories.

To avoid incorrect calibration reports when the entire procedure is repeated, delete all files with the serial number of the sensor from the "income" subdirectories before the first measurement. See also [Section 6.5, "Archiving"](#), on page 58.

### **6.4.1 Suppressing the Rohde & Schwarz logo**

By default, the logo of Rohde & Schwarz is placed in the upper right-hand corner of the calibration report.

#### **To suppress the Rohde & Schwarz logo**

1. Using a text editor, in the Windows directory, open the `recal.ini` file.
2. Go to the `[LAB ID]` section.
3. Make the following entry: `NoLogo = TRUE`.

## 6.4.2 Calculating a new EPROM file

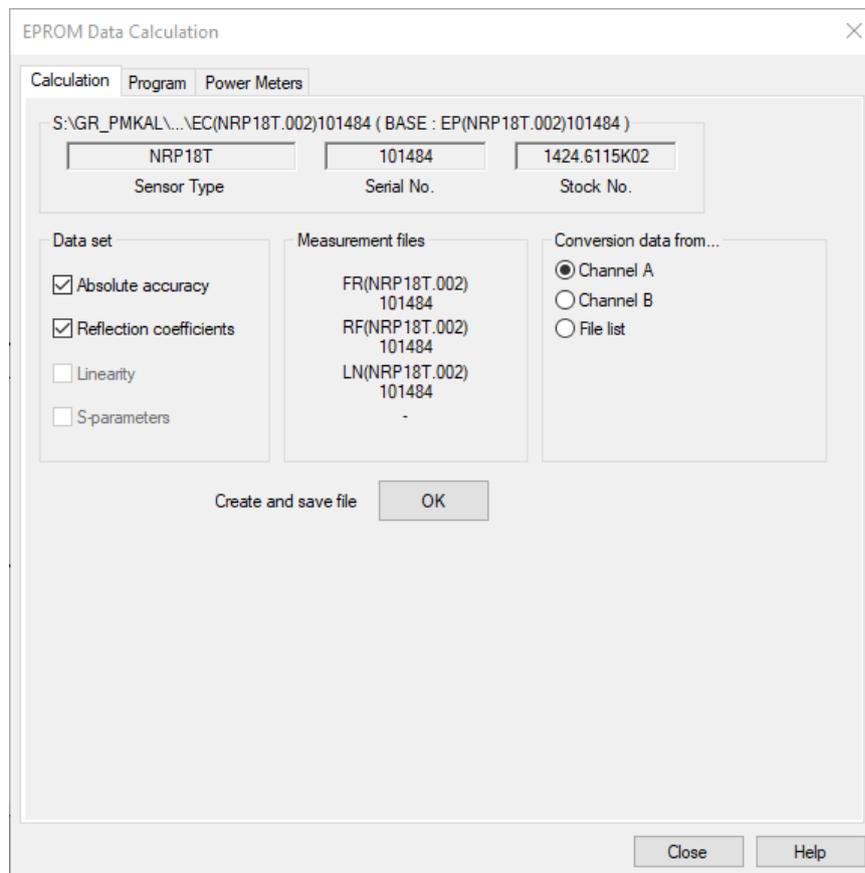


Figure 6-7: Calculation tab with measurement files

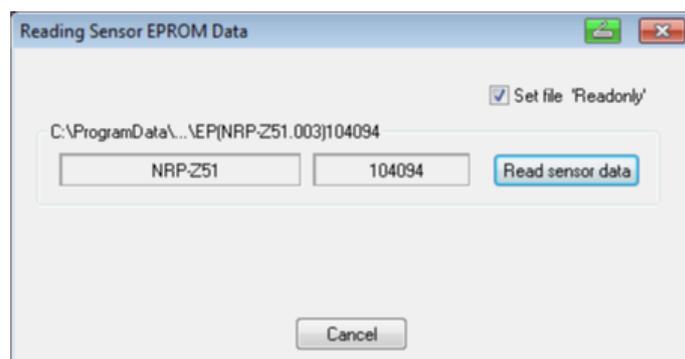
Access:  in the toolbar > "EPROM Data Calculation" dialog

The following section only applies to sensors whose data memories are to be overwritten. This process involves generating a new EPROM file from the measurement results and the (old) EPROM data of the sensor. You can load these EPROM data into the sensor via the R&S NRX or R&S NRVD or, for sensors with UV-erasable EPROM, with a suitable programming device.

### To configure the calculation

1. In the "EPROM Data Calculation" dialog, select the "Calculation" tab.
2. Under "Conversion data from", specify the source of the (old) EPROM file in one of the following ways:
  - Select the measurement channel to which the sensor in question is connected.
  - Select "File List" and select the appropriate EPROM file  
ep(<sensor><serial no.> from the list.

If the EPROM file is selected via the measurement channel, a prompt to read in sensor data is displayed.



3. Click "Read sensor data".
4. Wait for the end of the reading operation.
5. Close the dialog.

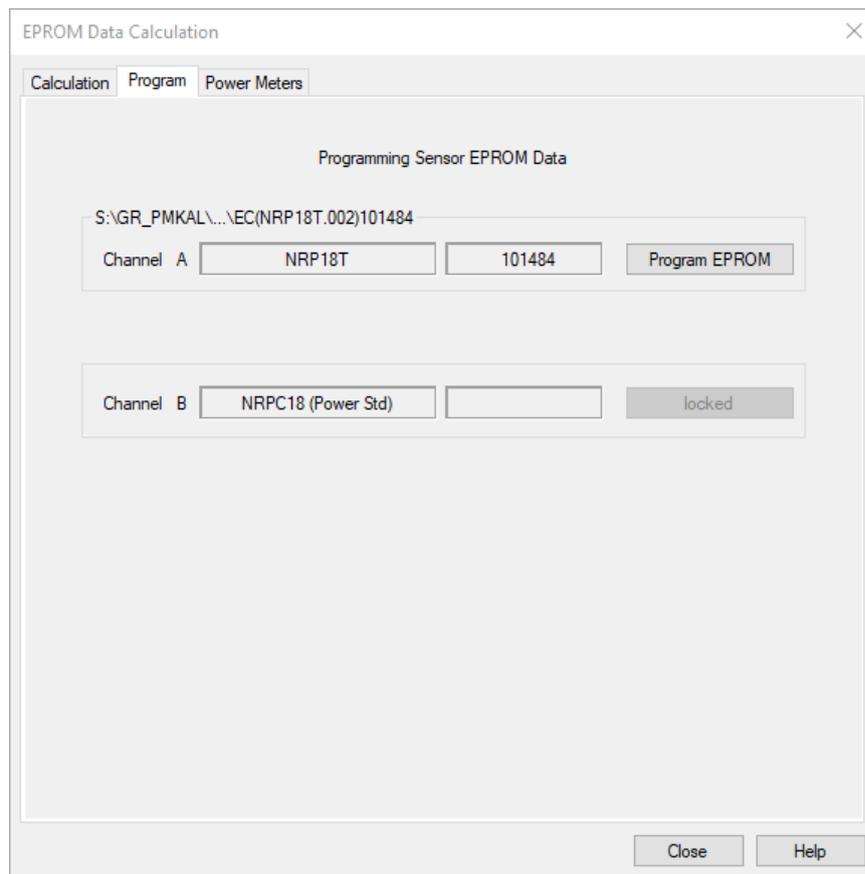
If measurement data is available for the selected EPROM file, this fact is indicated on the "EPROM Data Calculation" tab in the "Data set" field. The filenames are listed in the "Measurement files" field.

6. Click "Create and save file".

The R&S Recal+ software calculates a new EPROM file and saves it under the name `ec(<sensor><serial no.>`. When finished, an according message is displayed.

### 6.4.3 Overwriting the data memory of a sensor with flash EPROM

Any compatible file can be written to a sensor data memory. This file is a new file named `ec(<sensor><serial no.>` that is generated from measurement data. However, after the data memory has been overwritten, it is also possible to restore the original contents from the `eo(<sensor><serial no.>` file.



1. In the "EPROM Data Calculation" dialog, select the "Program" tab.
2. Connect the sensor to channel A or channel B on the R&S NRX or R&S NRVD, if not already done.
3. Click , if not already done.
4. Select the "Program" tab.  
Depending on the button label, various options are available for the measurement channel in question.
5. If the button label is "Program EPROM", a recalculated EPROM file `ec...` whose name contains the serial number of the sensor is available. To overwrite the data memory with this file:
  - a) Click "Program EPROM".
  - b) Confirm the operation again.
  - c) If you want to use a different file to overwrite the data memory, in the file manager or Explorer, delete the `ec...` file whose name contains the serial number of the sensor from the `... \recal\eprom.dat` directory.
  - d) Continue with [step 7](#).

6. If the button label is "Browse", no EPROM.ec... file whose name contains the serial number of the sensor is available. Select any file from the ...\\recal\\eprom.dat directory:
  - a) Select the file.
  - b) Click "Program EPROM".  
Confirm the operation.  
The flash EPROM is deleted and overwritten. Depending on the amount of correction data, this process can take a few minutes.
7. Click "Close".  
**Note:** If the button label is "Read only", it is not possible to write data to the data memory via the R&S NRVD (UV-EPROM).

## 6.5 Archiving

To prevent conflicts between old and new data, delete the files generated during calibration from the ...\\recal\\eprom.dat and ...\\recal\\measure.dat working directories and the ...\\income subdirectories before the individual sensor is calibrated again.

R&S Recal+ provides an archiving function allowing files to be copied to a new directory, deleted from the working directories and dearchived.

### 6.5.1 Copying files to archive

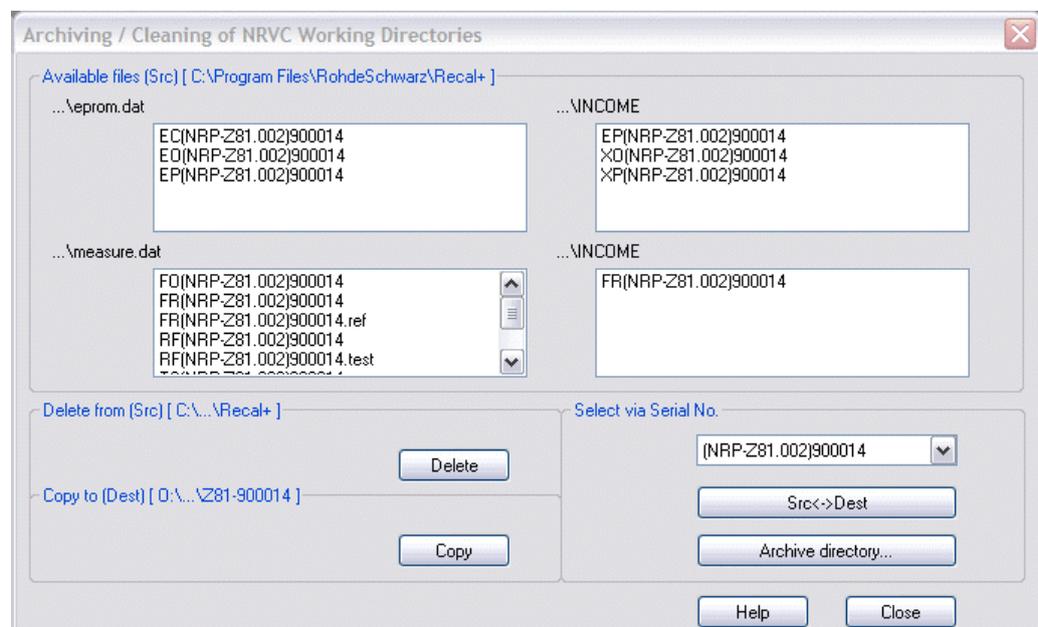


Figure 6-8: Archiving/Cleaning of NRVC Working Directories dialog

Access: "File" menu > "Archive"

1. Using Windows Explorer or the file manager, create an archive directory, e.g. ... \recal\archive.
2. In the "Archiving/Cleaning of NRPC Working Directories" dialog under "Select via Serial No.", select the sensor that you want to archive.  
All files available in the working directories are displayed.
3. Click "Archive directory" to select the archive directory.
4. Click "Copy".  
R&S Recal+ copies all files to the archive directory.  
The ... \eprom.dat, ... \measure.dat and ... \income subdirectories are created automatically.
5. Click "Delete" to delete all files from the working directories.  
**Note:** If you want to delete only some of the files, select these files first.

### 6.5.2 Fetching files from archive

This procedure is identical to the procedure for archiving except that you have to interchange the source and target by clicking "Src ↔ Dest". The archive directory is displayed under "Delete from (Src) [...]" and the working directory under "Copy to (Dest) [...]". You can switch back to archiving by clicking "Src ↔ Dest" again.

## 7 Verification

To prevent faulty calibration of sensors, it is necessary to check the measurement accuracy of the power standards using the verification set, R&S NRPCx-B1 option. Like a normal calibration of absolute accuracy, verification with the verification set is a quick and easy process that we recommend performing regularly (before usage or daily).

### 7.1 Built-in self-test

The R&S NRPC power standards are equipped with an internal reference circuit for checking the long-term stability of the integrated power sensor. The reference circuit includes a highly stable DC voltage source that can be used to supply a second heater on the transducer. The reference circuit is enabled whenever a built-in self-test is performed and an in-circuit test is executed.

#### To perform the self-test

1. In the toolbar, click .
2. In the "Measurement with Recal+" dialog, select the "NRP Sensor Test" tab.
3. Select the power standard.
4. Click the "Execute Test" button to perform the built-in self-test.

The test results consist of a global "SUCCESSFUL" or "FAILED" assessment along with individual test results. The result of the in-circuit test is displayed under "Test Heater Power Drift". Along with a "SUCCESSFUL" or "FAILED" assessment, the percent is indicated by which the sensitivity of the test cell has changed compared to the last calibration by German Accreditation Body (DKD) laboratory D-K-15195-01-01.

Perform a self-test of the R&S NRPCx-B1 verification sensor in the same manner. Here too, the change in the measured sensitivity compared to the last calibration by the German Accreditation Body laboratory mentioned above is displayed under "Test Heater Power Drift".

You can trigger in-circuit testing of the power standard as part of the self-test. The in-circuit testing is also executed automatically by the R&S Recal+ software before each calibration of absolute accuracy.

### 7.2 Comparison measurements with the R&S NRPCx-B1 verification sensor

For each R&S NRPC calibration kit, you can order an R&S NRPCx-B1 verification sensor as an option. It consists of a thermal sensor with an input impedance of 100  $\Omega$ .

## Comparison measurements with the R&amp;S NRPCx-B1 verification sensor

These thermal sensors have been adjusted on the associated power standard and exhibit only very minor errors compared to it. Therefore, large errors indicate that there has probably been some change in the components involved. Due to the strong mismatch of the verification sensor, it is possible to detect aging or wear and tear at an early stage. They are reflected in the power measurement accuracy and the matching.

**To use the R&S NRPCx-B1 verification sensor**

1. Verify that the calibration kit matches the verification sensor by comparing the serial numbers of the power standard with the data on the bottom of the verification sensor.
2. Prepare the measurement setup for checking the absolute accuracy as shown in [Section 5.4, "Power calibration setup for R&S power sensors"](#), on page 33.
3. Check the absolute accuracy with the associated verification sensor.
4. Perform one or more measurement cycles, depending on the requirement. Otherwise proceed as described in [Section 6.2.4, "Checking the absolute accuracy"](#), on page 48.

The averaged trace must lie within the tolerance band shown in the graphical display. The tolerance limits are significantly tighter compared to a normal thermal sensor. If the trace rises or falls uniformly over all the frequency range, this behavior indicates a change in the sensitivity of the power standard or the verification sensor. An oscillating frequency response as seen in [Figure 7-1](#) indicates that the matching conditions on the RF connection have changed. In this case, inspect the sensor visually and clean the connectors. If the ripple does not disappear despite cleaning the connectors of the verification sensor and the power standard, exchange the RF connector with the supplied replacement adapter. See [Section 15.2, "Exchanging the test port RF connector"](#), on page 107.

## Comparison measurements with the R&amp;S NRPCx-B1 verification sensor

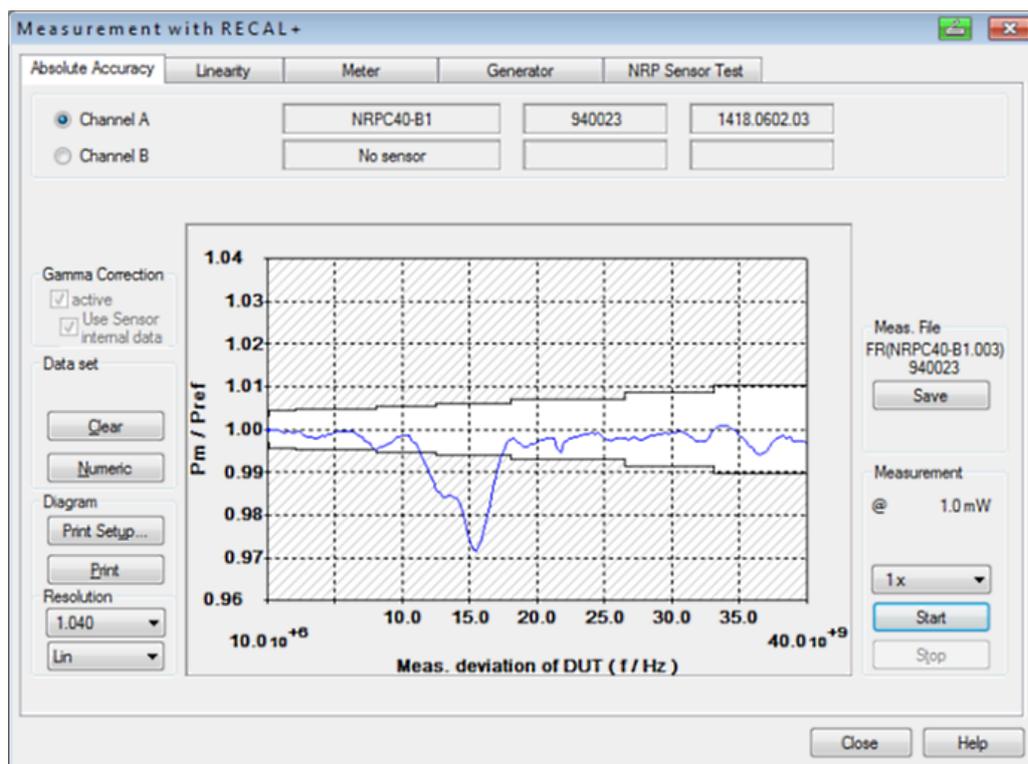


Figure 7-1: Verification result for an R&S NRPC40 power standard following damage to the RF connectors

The reference attenuators in the R&S NRPC18, R&S NRPC33 and R&S NRPC40 are not checked.



The verification measurement with the R&S NRPCx-B1 is saved as an FR file with a time stamp in the `Verification.dat` folder.

## 8 Measurements on a separate measurement setup

You can measure reflection, absolute accuracy and linearity also on separate measurement setups. After the measurement, transfer the measurement results in the form of standard ASCII files to R&S Recal+ for further processing. The required measurement frequencies and levels for each type of sensor are stored in a configuration file.

The configuration files are stored in the `...recal\config.dat` directory. You can read them with any standard text editor. The filename consists of the type designation of the sensor and the three-digit model code (padded on left with zeros). For example, for an R&S NRV-Z1 sensor with material number 0828.3018.03, the filename is `nrv-z1.003`.

Save the measurement results in the `...recal\measure.dat` directory in an ASCII file whose name consists of a header (`rf`: reflection; `ln`: linearity; `fr`: absolute accuracy; `sp`: S-parameter for attenuators) and the serial number of the sensor. The structure of these files is shown in [Table 8-2](#) to [Table 8-8](#).

### 8.1 Reflection

There are the following possibilities for the reflection measurement:

- Program-controlled measurement and transfer of the measurement data using the R&S ZVX\_RECAL program module in conjunction with selected network analyzers from Rohde & Schwarz. See also [Section 5.2.2, "Optional software"](#), on page 28.
- Manual or program-controlled measurement with any other suitable network analyzer and further processing of the measurement data:
  - Creating one file each with the reflection and measurement uncertainty data in Touchstone format and importing these files using R&S Recal+.
  - Manually creating a single file with reflection and measurement uncertainty data in a format compatible with R&S Recal+ and saving this file in the `...\Recal+\measure.dat` directory.

#### 8.1.1 Program-controlled reflection measurement with R&S ZVX\_RECAL

After the program is successfully installed, the "Measurement with Recal+" dialog  contains the "Reflection/S-Parameter" tab.

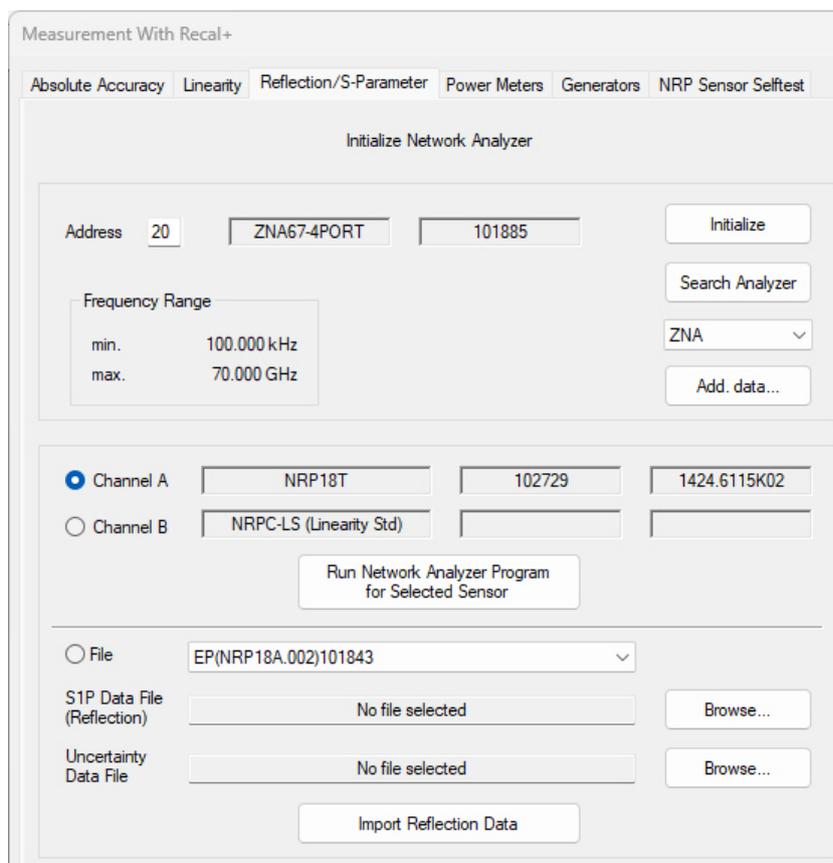


Figure 8-1: Reflection/S-Parameter tab

On this tab, you select the network analyzer and DUT and start the test program.

#### To prepare for the measurement

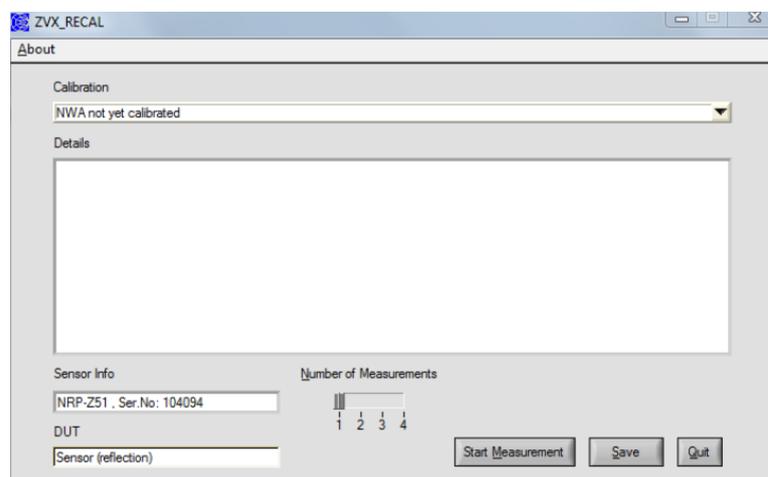
- ▶ At the network analyzer, save the data for the calibration kits you want to measure with.

#### To perform a reflection measurement

1. At the network analyzer, read in the calibration kit.
2. Connect the network analyzer to the test system via IEC/IEEE bus.
3. At the test system, start the R&S Recal+ software.
4. On the "Reflection/S-Parameter" tab, initialize vector network analyzer:
  - a) Select the type of network analyzer that is connected.
  - b) Use the "Search Analyzer" dialog to search for the GPIB address of the connected instrument. If you know the GPIB address, you can enter it into the "Address" field and skip the search.
  - c) Initialize the network analyzer.

5. On the "Reflection/S-Parameter" tab, select the sensor as "Channel A" or "channel B" of the basic power meter.
6. On the "Reflection/S-Parameter" tab, click "Run Network Analyzer Program for selected sensor".

The R&S ZVX\_RECAL program module starts in a separate dialog.

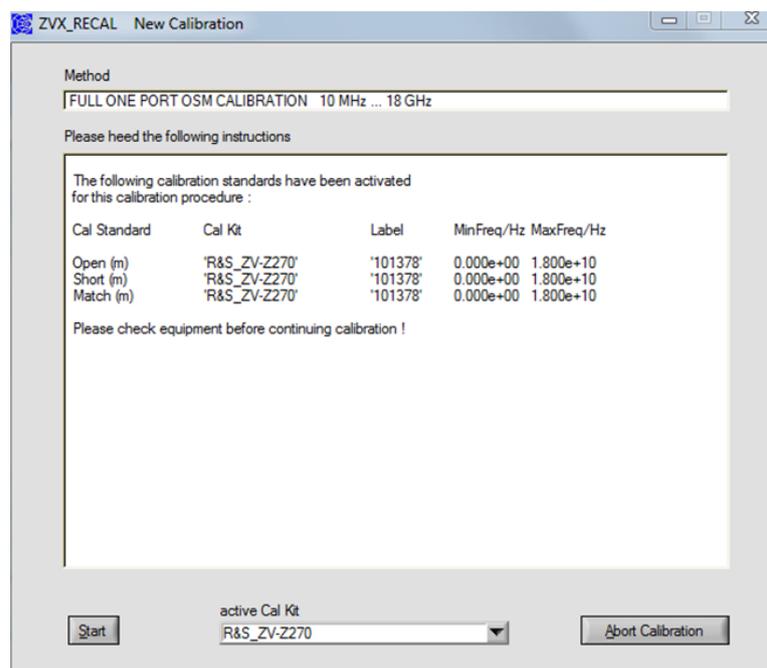


7. Calibrate the vector network analyzer. See ["To calibrate vector network analyzer"](#) on page 65.
8. Measure the reflection of the DUT. See ["To measure the reflection of the DUT"](#) on page 67.
 

**Tip:** We recommend checking the immunity of the sensor from mounting the connector in a different angular position by connecting it multiple times.
9. Click "Quit" to return to R&S Recal+.

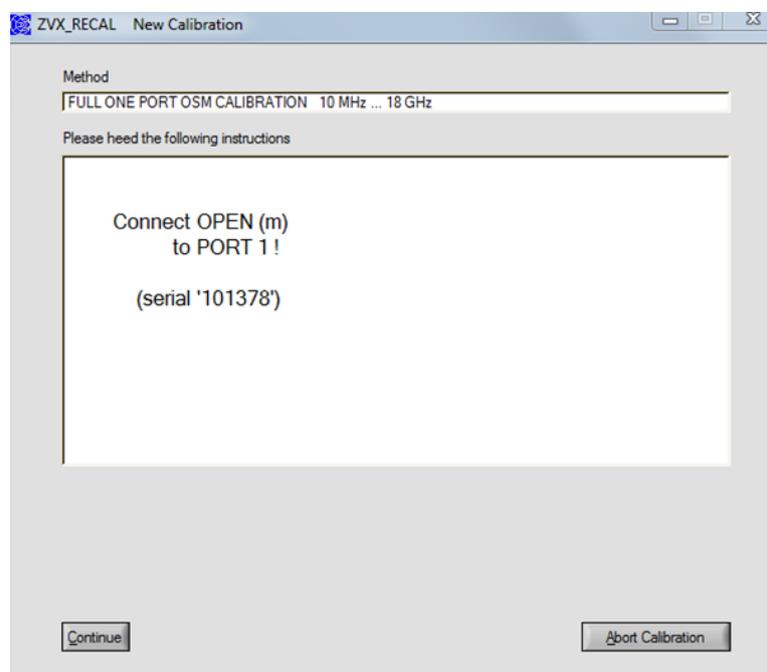
#### To calibrate vector network analyzer

1. In the "Calibration" list, select "New: One Port OSM".



- In the "active Cal Kit" list, select an appropriate calibration kit. The list only shows the calibration kits that are suitable for the connector to the DUT.
- Initiate the calibration by clicking "Start".

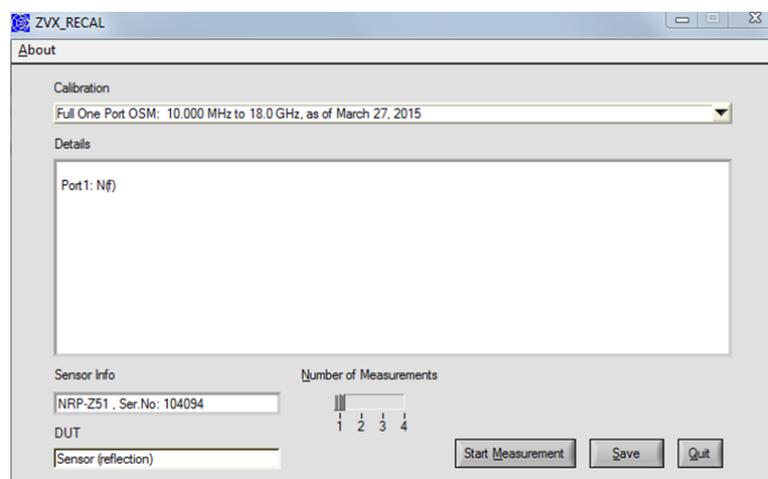
A dialog prompts you to connect the first calibration standard.



- Connect the requested calibration standard (check the serial number) to the network analyzer.
- Click "Continue".

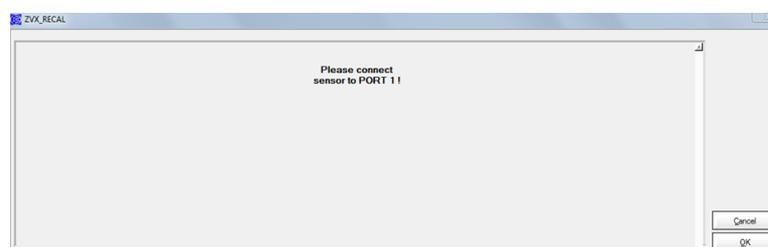
- Proceed in the same manner for the other calibration standards.
- Confirm the "Calibration complete" message with "OK".

The calibration of the network analyzer is saved for subsequent reuse. The R&S ZVX\_RECAL user interface is displayed in the foreground.



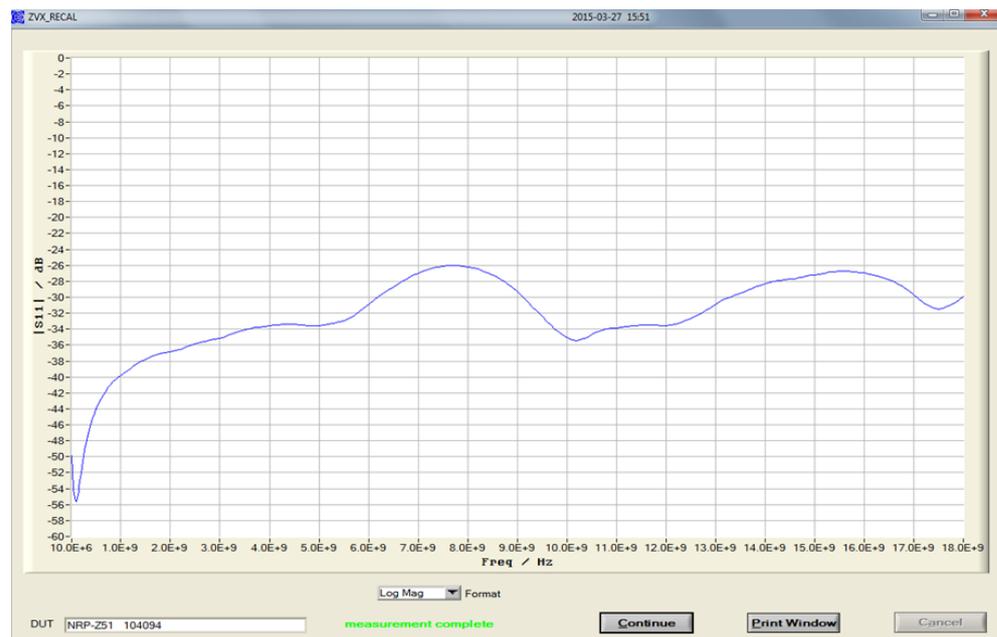
#### To measure the reflection of the DUT

- In the "Number of Measurements" list, select the number of measurements.
- Click "Start Measurement".
- When prompted, connect the DUT to the network analyzer.



- Click "OK".

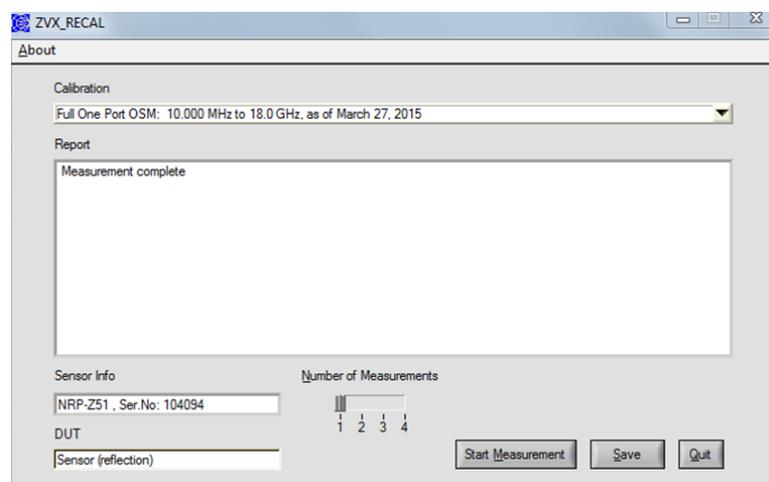
The measurement begins. After it is completed, the graphical display of the reflection measurement results is shown.



5. Click "Continue".

The result depends on the number of set measurements.

6. If you are prompted to connect the DUT in another angular position, do so.
7. If the R&S ZVX\_RECAL user interface is displayed with the message that the measurement is completed, click "Save".



An average measurement result is created from the individual measurements and saved in the ...\\recal+\\measure.dat directory as a file named as:

rf (<type designation>) <serial no.>

## 8.1.2 Information about reflection measurements with R&S ZVX\_RECAL

### Frequency range and number of frequencies

Both parameters are set solely as a function of the connector type. This means that sensors with identical connectors are adjusted at the same frequencies having the significant benefit that only a single calibration is required per connector type. The measurement points that are not necessary for the sensor are automatically discarded during subsequent evaluation of the measurement data. A standard value of 10 MHz is used as the lower frequency limit.

### Validity of the calibration

The network analyzer calibration is saved with the date. If multiple DUTs with the same connector type are adjusted in sequence, the calibration of the network analyzer calibration can be reused. You only need to ensure that the system data like directivity, reflection tracking and source match of the network analyzer have not changed significantly. Changes generally occur due to drift of the network analyzer vs. time or changes on the test port of the network analyzer. If you are in doubt, perform a new calibration using "New: One Port OSM (User)".

### Measurement uncertainty

Reflection measurements on power sensors are influenced primarily by the accuracy of the calibration kit and the stability of the network analyzer. The reflection of the actual sensor has only a secondary influence. The measurement uncertainty can be generalized as follows:

$$U = a + b |\Gamma|$$

The term  $a$  is independent of the measurement result and is primarily a function of the effective directivity. The term  $b$  considers the effective reflection tracking and the effective source match. Since power sensors generally exhibit very good matching, the influence of  $b$  tends to be small.

When calculating the measurement uncertainties, the R&S ZVX\_RECAL program module uses the values listed in [Table 8-1](#) for the term  $a$ . They are valid when using the recommended calibration kits, see [Table 5-13](#). For  $b$ , a conservative estimate of 0.04 is used in all cases.

**Table 8-1: Expanded measurement uncertainties ( $k = 2$ ) for a well-matched DUT (term  $a$ )**

Frequency range	N (50 Ω)	3.5 mm	2.92 mm	2.4 mm	1.85 mm
DC to 0.1 GHz	0.005	0.005	0.005	0.005	0.005
> 0.1 GHz to 2.4 GHz	0.005	0.005	0.005	0.005	0.005
> 2.4 GHz to 8.0 GHz	0.005	0.007	0.007	0.007	0.007
> 8.0 GHz to 12.4 GHz	0.005	0.009	0.009	0.009	0.009
> 12.4 GHz to 18.0 GHz	0.006	0.009	0.009	0.010	0.010
> 18.0 GHz to 26.5 GHz	-	0.011	0.011	0.014	0.014

Frequency range	N (50 Ω)	3.5 mm	2.92 mm	2.4 mm	1.85 mm
> 26.5 GHz to 33.0 GHz	-	0.011	0.011	0.015	0.015
> 33.0 GHz to 40.0 GHz	-	-	0.011	0.015	0.015
> 40.0 GHz to 50.0 GHz	-	-	-	0.017	0.017
> 50.0 GHz to 67.0 GHz	-	-	-	-	0.020

At low frequencies, vector network analyzers tend to exhibit a large, system-related statistical uncertainty. To reduce this uncertainty, R&S ZVX\_RECAL sets the bandwidth of the network analyzer accordingly. In addition, the measurement result for the 10 MHz frequency point is determined based on measurement results for multiple frequency points in the immediate vicinity of 10 MHz. Both steps help to reduce stochastic error influences considerably.

### Saving the measurement result

The measured reflection coefficients are saved along with the measurement uncertainties and general information in the `... \recal\measure.dat` directory. The file contains only the frequency points that are relevant for the applicable sensor. The filename is structured as follows:

```
rf (<type>) <serial no.>
```

For a sensor of type R&S NRV-Z15 with serial number 102972, it is as follows:

```
rf(NRP-Z21)102972
```

### Additional information about reflection measurements of R&S NRP18A(N) with R&S ZVX\_RECAL

Reflection measurements of R&S NRP18A(N) sensors with a frequency start from 8 kHz up to 18 GHz require two network analyzers. The first network analyzer covers the frequency range from 8 (9) kHz to 100 MHz, the second from 100 MHz up to 18 GHz. R&S ZVX\_RECAL measures the reflection using two vector network analyzers alternating in any order.

Depending on the measurements performed, the R&S ZVX\_RECAL user interface is displayed with "Measurement of a frequency subrange complete" (Figure 8-2) or a message that the measurement is completed.

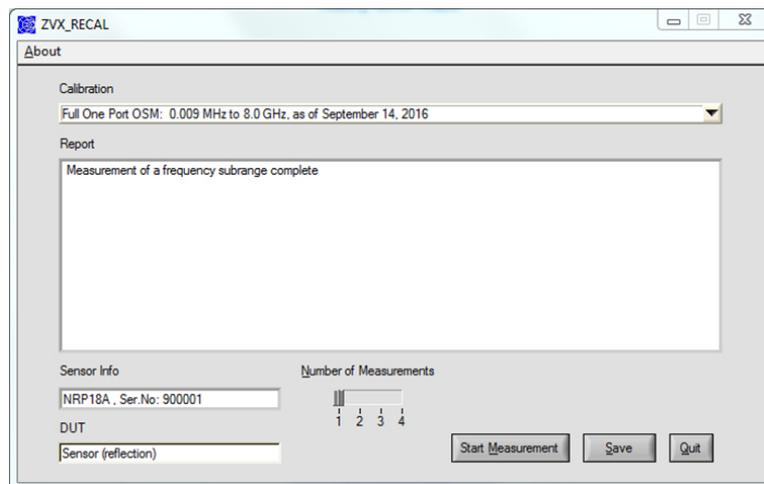


Figure 8-2: User interface after reflection measurement of a frequency subrange

### 8.1.3 Reflection measurement without using R&S ZVX\_RECAL

Supported network analyzers are listed in [Table 5-8](#) and [Table 5-10](#).

If the network analyzer used for the reflection measurement is not supported by the R&S Recal+ software, you need to:

- Configure the measurement properly.
- Save the measurement data in a format that is compatible with the R&S Recal+ software.

### 8.1.4 Configuring the network analyzer

All necessary information is saved in the configuration file for the sensor to be calibrated. The configuration files are stored in the `...\recal+\config32.dat` directory and the filename contains the type designation and variant identifier of the sensor. They are created in ASCII format and can be read using any standard editor. Fig. [Figure 8-3](#) shows parts of the configuration file for the R&S NRV-Z15 CW power sensor that is representative of all the sensors with only a single measurement path in this context.

```

freqLevel= 1.0E-6
...
frequencyresponse=
    50E6 , 1.0
    100E6 , 1.0
    500E6 , 1.0
    ...
    ...
    40E9 , 1.0
DataBlockEnd
...
reflectionCoefficients=
    50E6 , 0.070
    4.05E9 , 0.157
DataBlockEnd
...

```

**Figure 8-3: Excerpt from nrv-z15.002 configuration file for R&S NRV-Z15 sensor type with variant identifier 02**

**freqLevel** = Measurement level for calibration of absolute accuracy  
**frequencyresponse** = Measurement frequencies for calibration of absolute accuracy and matching  
**reflectionCoefficients** = Specified reflection coefficients: 50 MHz to 4 GHz  $\leq$  0.07, > 4 GHz to 40 GHz  $\leq$  0.157

For a thermal sensor or if the measurement data is not used for gamma correction of the calibration of absolute accuracy, the exact measurement level in the reflection measurement is not critical. Otherwise, the measurement level has to be as large as the value used for calibration of absolute accuracy. This value is saved in the configuration file under the `freqLevel` entry and has the unit of W for a power sensor. For values under 10  $\mu$ W (–20 dBm), the reflection measurement can be performed with no problem at a measurement level of –20 dBm. Reflection changes hardly occur if there is further level reduction. The selected measurement time is such that the measurement uncertainties resulting from the measurement noise remain small compared to the error influences that are due to the calibration of the network analyzer. The values in [Table 8-1](#) can be used as a starting point for the total measurement uncertainty.

For multipath sensors, multiple level specifications are present under the `freqNpathLevel` entry. For two-path sensors, use the second entry for the first path. For three-path sensors, use the second entry for the third path.

The measurement frequencies are listed under the `frequencyresponse` entry. These values apply for calibration of absolute accuracy and for the reflection measurement, and measured values must be available for these frequencies. To be able to define structured sweeps, it can be necessary to make measurements at other frequencies besides the listed ones. The R&S Recal+ software is configured for this use case and accepts additional frequency points, but only for the reflection measurement.

The measurement data is best saved as a Touchstone file in the `*.s1p` format for easy further processing, see [Section 8.1.5, "Formatting and saving the reflection measured values"](#), on page 73.

The configuration files for the sensors also include the limits specified in the specifications document for the magnitude of the linear reflection coefficient. These specifications are listed in the table under the `reflectionCoefficients` entry. The left column contains in each case the frequency starting at which the limit specified in the right column is valid. The value in the last row is logically valid up to the upper fre-

quency limit of the sensor. With the R&S URV5-Z2 and R&S URV5-Z4 voltage sensors, the reflection is measured at the male connector end. Terminate the female connector with the precision termination.

### 8.1.5 Formatting and saving the reflection measured values

To evaluate the network analyzer measurement data using the R&S Recal+ software, save the data in an RF file in the `...\recal+\measure.dat` directory. There are two possibilities:

- Creating one ASCII file each with the reflection and measurement uncertainty data in Touchstone format and importing these files using the R&S Recal+ software.
- Manually creating a single ASCII file with reflection and measurement uncertainty data in a format compatible with R&S Recal+ and saving this file in the `...\recal+\measure.dat` directory.

#### Importing reflection and measurement uncertainty files

This procedure is generally the simpler of the two possibilities since most network analyzers are capable of automatically generating measurement data in Touchstone format. You only need to create the measurement uncertainty file with its very simple format and import the data. The import requires the installation of the R&S ZVX\_RECAL program module, see [Section 8.1.1, "Program-controlled reflection measurement with R&S ZVX\\_RECAL"](#), on page 63.

#### To import the data

1. Save the measurement data of the network analyzer on a storage medium that the R&S Recal+ software can access.
2. Create the measurement uncertainty file.
3. Save the measurement uncertainty file on a storage medium that the R&S Recal+ software can access.
4. Start the R&S Recal+ software.
5. In the toolbar, click  to open the "Measurement with Recal+" dialog.
6. Select the "Reflection/S-Parameter" tab.
7. Select the sensor that the reflection data is associated with:
  - If this sensor is connected to an initialized base unit, click the corresponding option.
  - Otherwise, under "File", select the sensor from the list that appears. Of course, the second possibility assumes that the sensor has been plugged in at least once and its data was read out.
8. In the "S1P Data File (Reflection)" field, click "Browse" to select the file with the measurement data of the network analyzer.

9. In the "S1P Data File (Reflection)" field, click "Browse" to select the measurement uncertainty file.
10. Click "Import Reflection Data".

The R&S Recal+ software automatically generates a file in the RF format based on the two starting files and saves it in the ...\*recal+*\measure.dat directory. The filename consists of the sensor type designation, its variant identifier and the serial number.

### Structure of a file to import the measurement data of the network analyzer

Save the reflection coefficients measured at the individual frequencies with the real and imaginary parts in the Touchstone format (\*.s1p), see [Figure 8-4](#). Use a period as a decimal separator. In the header indicated with #, provide all the information needed to interpret the data:

- Frequency unit (HZ|KHZ|MHZ|GHZ)
- Identification of S-parameter data (S)
- Data format real/imaginary (RI)
- Reference impedance of 50 Ω (R 50)

You can insert comments directly after the header following an exclamation mark (!). Except for the mandatory file extension s1p, you can use any desired filename.

```
# HZ S RI R 50
! Rohde & Schwarz ZVA/B
!
! Frequency      Real part      Imaginary part
1.00000E+07     1.57630E-03   -2.22580E-03
5.00000E+07     1.37430E-03   -4.56010E-04
1.00000E+08     8.08320E-04   -1.36200E-04
3.00000E+08     1.45920E-04   -2.67880E-04
....
....
```

**Figure 8-4:** ASCII file with reflection data in Touchstone format



Save the reflection coefficients always with the real and imaginary parts. Other formats are not supported.

### Structure of a file with the uncertainties of the reflection measurement

Save the expanded linear uncertainties with  $k = 2$  as a function of the frequency. Use a period as a decimal separator. The left column defines the starting frequency of the interval in which the measurement uncertainty specified in the right column is valid. The interval ends with the starting frequency specified in the next row. The value in the last row is logically valid up to the upper frequency limit of the sensor. Usually, only a few entries are needed, and the measurement uncertainty file can be applied universally. The header indicated with # only needs to contain the frequency unit used in the table (HZ|KHZ|MHZ|GHZ) and the identifier for the measurement uncertainty file (*U*). You can insert comments directly after the header following an exclamation mark (!). You can select any desired filename.

```

# HZ U
!
! Frequency Uncertainty (k=2)
1.00E+07 0.005
2.41E+09 0.007
8.01E+09 0.009
12.41E+09 0.010

```

Figure 8-5: ASCII file with measurement uncertainties

### 8.1.5.1 Creating, editing and saving a file in RF format

Measurement files in RF format contain all the information needed for matching of a sensor. Besides the measurement data and measurement uncertainties, they also contain information about the sensor and calibration. [Table 8-2](#), [Table 8-3](#) and [Table 8-4](#) show examples of the format and content of these files. All mandatory entries are in bold, and all user-specific entries in normal font. The column on the right explains the various entries, i.e. these explanations are not included in the files.

The three examples differ in the presentation of the reflection-measured values. The preferred format with all the necessary information is shown in [Table 8-3](#). If the measurement data is available only in scalar form, use the format in [Table 8-4](#). You can use such files only for reporting and calculating the mismatch uncertainty in the calibration of absolute accuracy. A file like the one in [Table 8-2](#) provides the same information as one in the preferred format, but also includes the magnitudes of the reflection coefficients.

Save the files in the RF format in the `...\recal\measure.dat` directory. The filename must contain the type of the sensor and its serial number in the following format:

```
rf (<type>) <serial no.>
```

For a sensor of type R&S NRV-Z15 with serial number 102972, the filename is as follows:

```
rf(NRP-Z21)102972
```

After importing the Touchstone and measurement uncertainty file, it is sometimes helpful to edit an RF file created by R&S Recal+. Thus, you can add information that is not contained in the original files. For example, information about the instruments that were used, the name of the technician and data on the temperature and humidity, see [Table 8-2](#) to [Table 8-4](#).

Table 8-2: *rf(NRP-Z21)102972 measurement file for checking reflection (R&S power sensors, variant 1)*

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType = REFLECTION_DATA</b>	Designation as reflection data
<b>DeviceList =</b> "VNA, HP, 8510, 8430F9241, 199710A4435, 1998-05" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" The list is terminated with <b>DataBlockEnd</b> .
<b>TestEngineer = "Peter Schmidt"</b>	Name of test engineer

<b>Humidity</b> = "40 to 60" // % r.H.	Rel. humidity in % Comment line
<b>Temperature</b> = "20 to 26" // °C	Temperature range in °C Comment line
<b>SerialNo</b> = "102972"	Serial number
<b>StockNo</b> = "1081.2305.02"	Material number
<b>SensorType</b> = "NRP-Z11"	Type designation
<b>Date</b> = "2004-05-12"	Calibration date (12 May 2004)
<b>DataPoints</b> = 45	Number of frequencies
<b>ValuesPerPoint</b> = 5	Number of values per measurement point
<b>Value</b> = // Reflection coefficient of DUT // f/Hz   Magnitude   Uncert.   Real part   Imaginary part 5.000E+7 0.8783E-1 0.40E-2 0.7350E-1 0.4808E-2 1.000E+8 0.2650E-1 0.40E-2 0.1584E-2 0.2645E-1 5.000E+8 0.9632E-2 0.40E-2 0.2937E-2 0.9173E-2 ..... ..... 8.000E+9 0.32506E-1 1.20E-2 0.1742E-2 0.3245E-1 <b>DataBlockEnd</b>	Assignment of calibration values Comment line Comment line List of values, with columns separated by at least one space. The list is terminated with <code>DataBlockEnd</code> . Reflection coefficient: absolute value of the reflection coefficient Uncertainty: expanded measurement uncer- tainty (k=2) for the reflection coefficients

**Table 8-3: rf(NRP-Z21)102972 measurement file for checking reflection (R&S power sensors, variant 2)**

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType</b> = REFLECTION_DATA	Designation as reflection data
<b>DeviceList</b> = "VNA, HP, 8510, 8430F9241, 199710A4435, 1998-05" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" The list is terminated with <code>DataBlockEnd</code> .
<b>TestEngineer</b> = "Peter Schmidt"	Name of test engineer
<b>Humidity</b> = "40 to 60" // % r.H.	Rel. humidity in % Comment line
<b>Temperature</b> = "20 to 26" // °C	Temperature range in °C Comment line
<b>SerialNo</b> = "102972"	Serial number
<b>StockNo</b> = "1081.2305.02"	Material number

<b>SensorType</b> = "NRP-Z21"	Type designation
<b>Date</b> = "2004-05-12"	Calibration date (12 May 2004)
<b>DataPoints</b> = 45	Number of frequencies
<b>ValuesPerPoint</b> = 4	Number of values per measurement point
<b>Value</b> = // Reflection coefficient of DUT //f/Hz   Real part   Imaginary part   Uncertainty 5.000E+7 0.7350E-1 0.4808E-2 0.40E-2 1.000E+8 0.1584E-2 0.2645E-1 0.40E-2 5.000E+8 0.2937E-2 0.9173E-2 0.40E-2 ..... ..... 4.000E+10 0.1742E-2 0.3245E-1 1.20E-2 <b>DataBlockEnd</b>	Assignment of calibration values Comment line Comment line List of values, with columns separated by at least one space. The list is terminated with <code>DataBlockEnd</code> . Uncertainty: expanded measurement uncertainty (k=2) for the reflection coefficients

**Table 8-4: rf(NRV-Z15)843275.034 measurement file for checking reflection (R&S NRV-Z and R&S URV5-Z sensors)**

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType</b> = REFLECTION_DATA	Designation as reflection data
<b>DeviceList</b> = "VNA, HP, 8510, 8430F9241, 199710A4435, 1998-05" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" The list is terminated with <code>DataBlockEnd</code> .
<b>TestEngineer</b> = "Peter Schmidt"	Name of test engineer
<b>Humidity</b> = "40 to 60" // % r.H.	Rel. humidity in % Comment line
<b>Temperature</b> = "20 to 26" // °C	Temperature range in °C Comment line
<b>SerialNo</b> = "843275/034"	Serial number
<b>StockNo</b> = "1081.2305.02"	Material number
<b>SensorType</b> = "NRV-Z15"	Type designation
<b>Date</b> = "2004-05-12"	Calibration date (12 May 2004)
<b>DataPoints</b> = 45	Number of frequencies

<b>ValuesPerPoint = 3</b>	Number of values per measurement point
<b>Value =</b> // Reflection coefficient of DUT //f/Hz   Magnitude   Uncertainty 5.000E+7 0.8783E-2 0.40E-2 1.000E+8 0.8820E-2 0.40E-2 5.000E+8 0.9124E-2 0.40E-2 ..... ..... 4.000E+10 8.7455E-2 1.20E-2 <b>DataBlockEnd</b>	Assignment of calibration values Comment line Comment line List of values, with columns separated by at least one space. The list is terminated with <code>DataBlockEnd</code> . Uncertainty: expanded measurement uncertainty (k=2) for the reflection coefficients

## 8.2 S-parameter file for sensors with attenuators

In the sensor data memory of the R&S NRP18S-xx and R&S NRP-Z22/23/24/92 power sensors, two calibration data sets are saved. The first data set in the sensor data memory the power sensor. The second data set in the sensor data memory the attenuator in the form of all four S-parameters. You can refresh the data for the attenuator by providing R&S Recal+ with a file with current measurement data.

Table 8-5 shows the structure of this file type in RF format for a power sensor of type R&S NRP-Z22. Beside general information, this file contains a complete set of complex S-parameters for the attenuator. Provide the S-parameters exclusively in linear notation. For the measurement uncertainties, distinguish between the reflection and transmission parameters. For the reflection coefficients  $s_{11}$  and  $s_{22}$ , the absolute uncertainties are necessary, while for the transmission coefficients  $s_{12}$  and  $s_{21}$  the relative uncertainties (in dB) are necessary. Expand the uncertainties by the factor  $k = 2$  and refer in each case to the magnitudes.

The complex reflection coefficients of the power attenuators change faster vs. frequency than the reflection coefficients at the input of the power sensors. This fact is related to the longer line lengths inside the attenuators. Therefore, the measurement frequencies in the calibration data set for an attenuator are more tightly spaced than the calibration frequencies of the power sensor. If the spacing between the frequency points is too large, significant errors arise in gamma correction between the power sensor and attenuator. In general, a frequency spacing of 50 MHz is adequate. It is best to select the frequency points in the existing calibration data set that you can read out in the "Create NRP View file" dialog and save as an ASCII file in the `...\recal+\config32.dat` directory. The parameters for the attenuator are listed under "S-Parameter Calibration Data".

The R&S ZVX\_RECAL program module does not support the calibration of the attenuators since the possibility of significant measurement errors is greater compared to power calibration. Accordingly, we recommend only experienced personnel performing calibration of attenuators using suitable measurement setups.

**Table 8-5: SP(NRP-Z22.002)100042 measurement data file for the S-parameters for the attenuator of an R&S NRP-Z22 sensor**

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType = S_PARA_DATA</b>	S-parameter measurement data
<b>DeviceList =</b> //"<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" "VNA, HP, 8510, 8430F9241, 199710A4435, 1998-05" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component. The list is terminated with <code>DataBlockEnd</code> .
<b>TestEngineer = "Peter Schmidt"</b>	Name of test engineer
<b>Humidity = "40 to 60"</b> // % r.H.	Rel. humidity in % Comment line
<b>Temperature = "20 to 26"</b> // °C	Temperature range in °C Comment line
<b>SerialNo = "654321"</b>	Component serial number
<b>StockNo = "1234.5678.90"</b>	Material number of component
<b>ComponentType = "Weinschel 10 dB attenuator"</b>	Component type designation
<b>Date = "2001-10-21"</b>	Calibration date
<b>CalibrationLab = "R &amp; S Messgerätebau Memmingen"</b>	Calibration location
<b>Family = ALL</b>	Not a member of any specific sensor family
<b>DataPoints = 360</b>	Number of measurement frequencies
<b>ValuesPerPoint = 13</b>	Number of columns per frequency point
<b>ComplexData = TRUE</b>	Indicates that the measurement values are real and imaginary components of a complex value
<b>Value =</b> //f/Hz re_s11 im_s11 unc_s11 re_s12 im_s12 unc_s12 re_s21 im_s21 unc_s21 re_s22 im_s22 unc_s22 5.0E7 0.88E-2 0.40E-2 0.005 3.161E-1 0.240E-4 0.04 3.180E-1 0.861E-4 0.04 0.12E-1 0.11E-3 0.005 ..... ..... 18.0E9 0.88E-1 0.22E-1 0.010 0.111E-2 2.462E-1 0.07 0.263E-2 2.501E-1 0.07 0.72E-1 0.41E-1 0.010 <b>DataBlockEnd</b>	Assignment of calibration values Comment line (no line break!) List of values, one line per measurement frequency, with columns separated by at least one space. The list is terminated with <code>DataBlockEnd</code> .

## 8.3 Linearity calibration

You can perform the calibration of the linearity on a separate power calibration measurement setup.

Transfer the measurement results to the R&S Recal+ software in an ASCII file in accordance with [Table 8-6](#). The ASCII file contains the following:

- General information
- Measured power value pairs for the standard and the DUT at each frequency point with the expanded ( $k = 2$ ) measurement uncertainty  $U_{lin}$  in dB as the third quantity

You can obtain the measurement levels from the DUT configuration file:

```

...
linFilter = 7
...
linLevel =
  1.00E-006
  1.58E-006
  ...
  ...
  2.51E-2
DataBlockEnd
...
freqLevel = 1.0E-6
...

```

**Figure 8-6: Extract from nrv-z15.002 configuration file (linearity)**

linFilter = DUT filter setting

linLevel = Power steps ( $\pm 0.5$  dB)

freqLevel = Power ( $\pm 0.5$  dB) at the reference point

**Table 8-6: In(NRP-Z11.002)900123 measurement file for checking the linearity**

[SENSOR-MEAS-DATA-FILE]	Designation as measurement file
CalDataType = LIN_RESPONSE	Designation as linearity data
Family = NRP	NRP (value for all R&S power sensors) or NRV (value for R&S NRV and R&S URV5-Z)
DeviceList = "Power Sensor, R&S, NRV-Z1, 856345/011, 199A5, 1998-05" "Power Meter, R&S, NRVD, 845123/018, 567B221, 1999-10" "..." DataBlockEnd	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>," The list is terminated with DataBlockEnd.
TestEngineer = "Peter Schmidt"	Name of test engineer
Humidity = "40 to 60" // % r.H.	Rel. humidity in % Comment line
Temperature = "20 to 26" // °C	Temperature range in °C Comment line
SerialNo = "900123"	Serial number

<b>StockNo</b> = "1138.3004.02"	Material number
<b>SensorType</b> = "NRP-Z11"	Type designation
<b>CalibrationLab</b> = "SE2 Service Dept"	Name of Calibration Lab
<b>Date</b> = "2004-05-12"	Calibration date (12 May 2004)
<b>RefValue</b> = 1.0024	$P_{DUT} / P_{ref}$ for the reference point
<b>RefUnit</b> = -1	Reference value code
<b>TestFrequency</b> = 500.0E6	Measurement frequency
<b>DataPoints</b> = 24	Number of frequencies
<b>ValuesPerPoint</b> = 3	Number of values per measurement point
<b>ValueUnit</b> = W	Unit of Value, V for sensors that are marked as VoltageSensor in the config file
<b>Value</b> = // P_ref/W P_DUT/W uncertainty U_lin/dB 9.95123E-7 9.9751E-7 2.50E-2 1.57230E-6 1.5761E-6 2.50E-2 ..... ..... 2.46220E-2 2.4631E-2 2.50E-2 <b>DataBlockEnd</b>	Assignment of calibration values Comment line List of values, columns separated by at least one space. Uncertainty U_lin/dB: expanded measurement uncertainty (k=2) in dB for power ratio measurements. The list is terminated with DataBlockEnd.
<b>SubstrateTemperature</b> = 0.300000000E+3	Only NRP and FSH, fixed value.

## 8.4 Absolute accuracy calibration

You can perform the calibration of the absolute accuracy on a separate power calibration measurement setup.

Transfer the measurement results to the R&S Recal+ software in an ASCII file in accordance with [Table 8-7](#) for R&S NRV-Z or R&S URV5-Z sensors, or in accordance with [Table 8-8](#) for R&S power sensors. In addition to general information, this file contains the measured power value pairs for the standard and the DUT at each frequency point. You can obtain the measurement frequencies and the calibration power levels from the DUT configuration file:

```

...
FRQREF = 2
frequencyresponse=
  50E6 , 1.0
  100E6 , 1.0
  500E6 , 1.0
  ...
  ...
  40E9 , 1.0
DataBlockEnd
...
freqLevel = 1.0E-6
freqFilter = 7
...

```

Figure 8-7: Extract from configuration file nrv-z15.002 (absolute accuracy)

FRQREF = Reference frequency index  
frequencyresponse = Measurement frequencies  
freqLevel = Meas. power ( $\pm 1.0$  dB)  
freqFilter = Filter setting

For every frequency point, state the expanded ( $k = 2$ ) measurement uncertainty  $U_{abs}$  in dB as the fourth quantity in the measurement file. The expanded ( $k = 2$ ) measurement uncertainty  $U_{ref,abs}$  of the calibration system includes:

- Mismatch uncertainty
- Component for the base unit
- Ambient temperature
- Component that considers the effect of harmonics for the R&S NRV-Z6 and R&S NRV-Z15 diode sensors.

$$U_{abs} = 2 \cdot \sqrt{\left(\frac{U_{ref,abs}}{2}\right)^2 + u_{NRVD,1}^2 + [\alpha_{T,DUT}(T - 296.15 \text{ K})]^2 + u_{h,one}^2}$$

$$u_{NRVD,1} = 0.0039 \text{ dB}$$

$$\alpha_{T,DUT} = 0.0015 \text{ dB/K} \quad [\text{R \& S NRV - Z6/ - Z15}]$$

$$0.0005 \text{ dB/K} \quad [\text{R \& S NRV - Z52/ - Z55}]$$

T = sensor temperature in K

$$\frac{u_{h,one}}{\text{dB}} = \sqrt{\frac{P_{DUT}}{4 \mu\text{W}} \cdot 10^{-\frac{S}{20\text{dB}}}}$$

$P_{DUT}$  is the power at the DUT, S the harmonic ratio. At a measurement power of  $1 \mu\text{W}$  and a harmonic ratio of 25 dB, for example, the uncertainty  $u_{h,one} = 0.028$  dB.

Enter the default frequency defined for the sensor type in question must be entered as the reference frequency RefValue. The default frequency is the frequency that is accepted by the base unit when the frequency response correction is turned off.

You can find the default frequency in the corresponding configuration file, where the index FRQREF indicates the corresponding value in the frequency table (index 0 = 1st

measurement frequency). In the example above ( $FRQREF = 2$ ),  $RefValue = 5E8$  is the value to enter.

**Table 8-7: fr(NRV-Z15.002)843275.034 measurement file for checking absolute accuracy**

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType = FREQ_RESPONSE</b>	Designation as measurement data for absolute accuracy
<b>Family = NRV</b>	Also R&S NRV-Z for R&S URV5-Z sensors
<b>DeviceList =</b> "Power Sensor, HP, 8478B, 3318A2465, 199A5, 1998-05" "Power Meter, HP, 432A, 1234A10012, 199A6, 1999-10" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" The list is terminated with <code>DataBlockEnd</code> .
<b>TestEngineer = "Peter Schmidt"</b>	Name of test engineer
<b>Humidity = "40 to 60"</b> // % r.H.	Rel. humidity in % Comment line
<b>Temperature = "20 to 26"</b> // °C	Temperature range in °C Comment line
<b>SerialNo = "843275/034"</b>	Serial number
<b>StockNo = "1081.2305.02"</b>	Material number
<b>SensorType = "NRV-Z15"</b>	Type designation
<b>Date = "2004-05-12"</b>	Calibration date (12 May 2004)
<b>FKF = TRUE</b>	Measurement done with frequency correction turned on, is always <code>TRUE</code> .
<b>RefValue = 500.00000E+6</b>	Reference frequency
<b>RefUnit = Hz</b>	Reference frequency unit
<b>TestLevel = 1.000000000E-6</b>	Nominal level for Measurement
<b>GammaCorrection = TRUE</b>	Measurement with/without gamma correction
<b>DataPoints = 45</b>	Number of frequencies
<b>ValuesPerPoint = 4</b>	Number of values per measurement point

<b>ValueUnit</b> = W	Unit of <b>Value</b> and <b>TestLevel</b> , V for sensors that are marked as <b>VoltageSensor</b> in the config file.
<b>Value</b> = // f/Hz Ref. pwr./W DUT pwr./W Uncertainty U_abs/dB 5.00000E7 1.0034E-6 9.9987E-7 1.44E-2 1.00000E8 1.0141E-6 1.0187E-6 1.46E-2 5.00000E8 1.0273E-6 1.0337E-6 1.51E-2 .... .... 4.00000E10 9.0114E-7 8.8547E-7 2.88E-1 <b>DataBlockEnd</b>	Assignment of calibration values Comment line List of values, columns separated by at least one space. Uncertainty U_abs/dB: Expanded measurement uncertainty (k=2) for calibration of absolute accuracy. The list is terminated with <b>DataBlockEnd</b> .

Table 8-8: fr(NRP-Z11.002)900123 measurement file for checking absolute accuracy

<b>[SENSOR-MEAS-DATA-FILE]</b>	Designation as measurement file
<b>CalDataType</b> = <b>FREQ_RESPONSE</b>	Designation as measurement data for absolute accuracy
<b>Family</b> = NRP	Also NRP for R&S FSH-Z sensors
<b>DeviceList</b> = "Power Sensor, HP, 8478B, 3318A2465, 199A5, 1998-05" "Power Meter, HP, 432A, 1234A10012, 199A6, 1999-10" "..." <b>DataBlockEnd</b>	List of measuring devices; a separate line is to be provided for each component: "<designation>, <manufacturer>, <type>, <serial no.>, <certificate no.>, <calibration expiry date>" The list is terminated with <b>DataBlockEnd</b> .
<b>TestEngineer</b> = "Peter Schmidt"	Name of test engineer
<b>Humidity</b> = "40 to 60" // % r.H.	Rel. humidity in % Comment line
<b>Temperature</b> = "20 to 26" // °C	Temperature range in °C Comment line
<b>SerialNo</b> = "900123"	Serial number
<b>StockNo</b> = "1138.3004.02"	Material number
<b>SensorType</b> = "NRP-Z11"	Type designation
<b>Date</b> = "2004-05-12"	Calibration date (12 May 2004)
<b>CalibrationLab</b> = "SE2 Service Dept"	Name of calibration laboratory
<b>FKF</b> = TRUE	Always TRUE for R&S power sensors
<b>RefValue</b> = 500.00000E+6	Reference frequency
<b>RefUnit</b> = Hz	Reference frequency unit
<b>GammaCorrection</b> = TRUE	Measurement with/without gamma correction

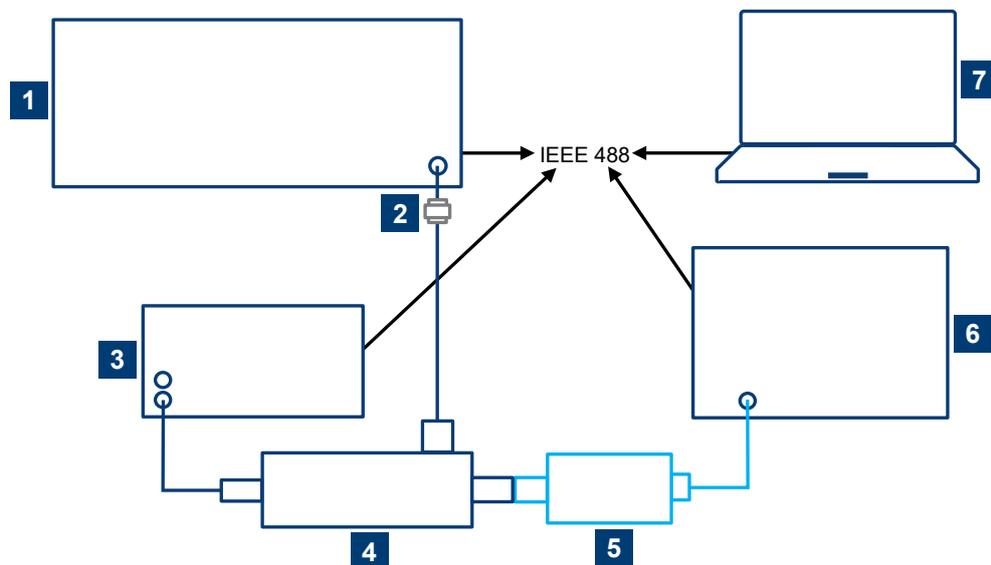
<b>TestLevels</b> = 10.00E-6 1.00E-3 1.00E-3 <b>DataBlockEnd</b>	Nominal levels of measurements for 3-path sensors For R&S NRP-Z51: TestLevel = ... without DataBlockEnd
<b>DataPoints</b> = 45	Number of frequencies
<b>ValuesPerPoint</b> = 4	Number of values per meas. point
<b>ValueUnit</b> = W	Unit of Value and TestLevel (always W for R&S power sensors).
<b>Value</b> = // f/Hz Ch1_Ref_Pwr/W Ch1_DUT_Pwr/W Ch1_unc/dB Ch2_Ref_Pwr/W Ch2_DUT_Pwr/W Ch2_unc/dB Ch3_Ref_Pwr/W Ch3_DUT_Pwr/W Ch3_unc/dB 10.00000E+6 0.012600394E-3 0.012583287E-3 0.02949060 1.26928072E-3 1.2674270E-3 0.0267329 1.269419463E-3 1.268397333E-3 0.027131145 .... 8.0000000E+9 0.0101924E-3 0.01018197E-3 0.04508305 1.0275804E-3 1.02591166E-3 0.0363610 1.02847939E-3 1.027831333E-3 0.036797888 <b>DataBlockEnd</b>	Assignment of calibration values Comment line, data must be given in this order List of values (here NRP), number of columns must be ValuesPerPoint, columns separated by at least one space. Uncertainty U_abs/dB: Expanded measure- ment uncertainty (k=2) for calibration of absolute accuracy. The list is terminated with DataBlockEnd.
<b>SubstrateTemperature</b> = 0.300000000E+3	Only for R&S power sensors, fixed value.

## 9 R&S NRV-Z, R&S URV5-Z sensors and R&S NRVD power meter

This section describes the measurement equipment and setup for the discontinued R&S NRV-Z and R&S URV5-Z power sensor families.

### 9.1 Power calibration of R&S NRV-Z and R&S URV5-Z sensors

#### 9.1.1 Requirements for all R&S NRV-Z, R&S URV5-Z sensors



**Figure 9-1: Setup for calibrating absolute accuracy**

- 1 = Generator
- 2 = Depending on the generator used, an adapter for connecting the RF cable can be required.
- 3 = R&S NRX power meter; configure the R&S NRX as "Meter2", see [Section 9.3, "Configuring the R&S NRVD power meter"](#), on page 89.
- 4 = R&S NRPC; depending on the sensor type, an attenuator or termination is also required, see [Table 9-1](#).
- 5 = DUT; R&S NRV-Z32/33/53/54 are measured with the corresponding attenuator.
- 6 = R&S NRVD
- 7 = Controller, a computer with R&S Recal+ installed

Generator, power meters and computer are connected via their IEEE-488 interfaces.

For details on the measurement equipment, see:

- [Section 5.1, "Supported R&S power sensors"](#), on page 23
- [Section 5.2, "Controller"](#), on page 26

- [Section 5.3.2, "R&S NRX power meter"](#), on page 29
- [Section 5.3.3, "Generators for calibration of absolute accuracy"](#), on page 29
- [Section 5.3.4, "Generators for calibration of linearity"](#), on page 31
- [Section 5.3.5, "Vector network analyzers for calibration of matching"](#), on page 31

## 9.1.2 Further equipment for the sensor types

Table 9-1: Further equipment for the sensor types

Sensor type	Reference attenuator (20 dB)	Precision termination	Calibration kit	See also
R&S NRV-Z2/5/8/51	-	-	R&S NRPC18	<a href="#">Table 5-1</a>
R&S NRV-Z32/33/53/54	-	-	R&S NRPC18	<a href="#">Table 5-1</a>
R&S NRV-Z1/4/7/31	x	-	R&S NRPC18	<a href="#">Table 5-1</a>
R&S URV5-Z2	x	x	R&S NRPC18	<a href="#">Table 5-2</a>
R&S URV5-Z4	-	x	R&S NRPC18	<a href="#">Table 5-2</a>
R&S URV5-Z7	x *)	-	R&S NRPC18	<a href="#">Table 5-2</a>
R&S NRV-Z52	-	-	R&S NRPC33	<a href="#">Table 5-3</a>
R&S NRV-Z6	x	-	R&S NRPC33	<a href="#">Table 5-3</a>
R&S NRV-Z55	-	-	R&S NRPC40	<a href="#">Table 5-4</a>
R&S NRV-Z15	x	-	R&S NRPC40	<a href="#">Table 5-4</a>

\*) Two adapters are required: 50  $\Omega$  adapter (R&S URV5-Z50) and adapter for R&S URV5-Z50 adapter; the order is shown in [Figure 9-2](#)

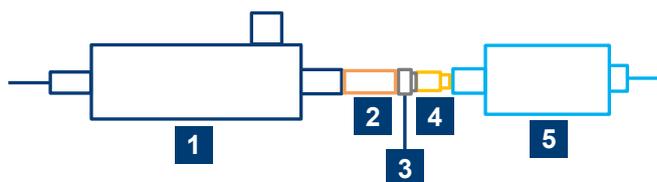
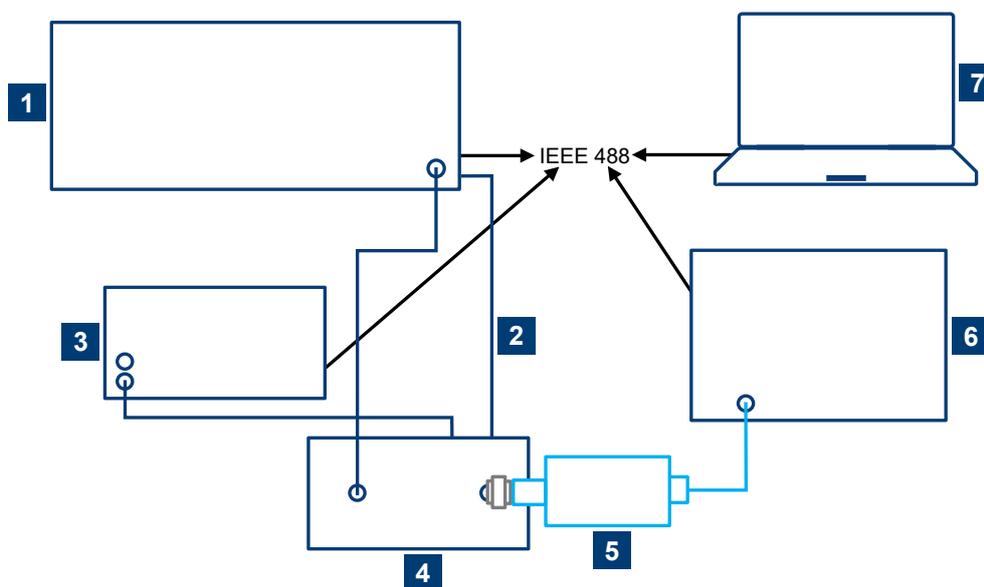


Figure 9-2: Adapter setup for R&S URV5-Z7

- 1 = R&S NRPC
- 2 = Reference attenuator
- 3 = Adapter N (male) to BNC (male)
- 4 = 50  $\Omega$  adapter (R&S URV5-Z50)
- 5 = DUT

## 9.2 Linearity calibration of R&S NRV-Z and R&S URV5-Z sensors

The calibration of linearity is not supported for R&S URV5-Z2 (55, 56), R&S URV5-Z4 (55, 56) and R&S URV5-Z7.



**Figure 9-3: Setup for linearity calibration of R&S NRV-Z and R&S URV5-Z sensors**

- 1 = R&S SMA100B generator
- 2 = 10 MHz reference; connect the internal reference oscillator of the generator to the reference clock of the R&S NRPC-LS.
- 3 = R&S NRX power meter; for connecting R&S NRPC-LS, use an R&S NRP-ZK8 interface cable.
- 4 = R&S NRPC-LS
- 5 = DUT; depending on the DUT used, an adapter for connecting to the test port of the R&S NRPC-LS can be required. See [Table 9-2](#).
- 6 = R&S NRVD power meter
- 7 = Controller, a computer with R&S Recal+ installed

**Table 9-2: Adapter for connecting the DUT to the R&S NRPC-LS**

Connector of DUT	Calibration kit	Adapter included in calibration kit
3.5 mm	R&S NRPC33	N (male) to SMA (female)
2.92 mm	R&S NRPC40	N (male) to SMA (female)

### Additional requirements for R&S URV5-Z sensors

- R&S SMA100B options  
Frequency option up to 20 GHz and the output power options "High output power" and "Ultra high output power" are required.
- Matched termination is required with a maximum input power of at least 2 W.  
We recommend using the attenuator included in the R&S NRPC18 calibration kit.  
You can also use an attenuator with an attenuation of at least 20 dB.

For details on the measurement equipment, see:

- [Section 5.1, "Supported R&S power sensors"](#), on page 23
- [Section 5.2, "Controller"](#), on page 26
- [Section 5.3.2, "R&S NRX power meter"](#), on page 29
- [Section 5.3.3, "Generators for calibration of absolute accuracy"](#), on page 29
- [Section 5.3.4, "Generators for calibration of linearity"](#), on page 31
- [Section 5.3.5, "Vector network analyzers for calibration of matching"](#), on page 31

## 9.3 Configuring the R&S NRVD power meter

For calibrating the R&S NRV-Z and R&S URV5 sensors, an R&S NRVD base unit is also required. Overall, you can control two base units:

- Basic power meter for connecting to the DUT
- R&S NRX for connecting to one or up to four power standards from the R&S NRPC calibration kit

The following tables show the possible combination.

Basic power meter	Meter2
R&S NRVD A / B	R&S NRX A / B / C / D
DUT (R&S NRV-Z or R&S URV5-Z)	Up to four R&S NRPC

### 9.3.1 Initializing the R&S NRVD

1. In the "Options" menu, open the "Remote Devices..." dialog.
2. Select the "Meter" tab.
3. Under "Basic Power Meter" panel, click "Search NRVD".

The calibration software searches for an R&S NRVD that is connected to the IEC/IEEE bus. If the search is successful, the address of the R&S NRVD is displayed in the address field.

**Tip:** If you already know the IEC/IEEE bus address of the R&S NRVD, the search is not necessary. You can simply enter the address.

4. If necessary, click "Search NRVD" again to find a second R&S NRVD base unit.
5. Click "Initialize".

The R&S Recal+ calibration software initializes the R&S NRVD that was found at the specified address.

6. Click "Add data ...".

7. Enter the calibration expiry date and the "Certificate No." for the addressed R&S NRVD.
8. Click "OK".
9. If a second R&S NRVD is available, click "Use Meter 2" and proceed accordingly.
10. If an R&S NRX base unit is connected to the measurement setup:
  - a) Under "Basic Power Meter" panel, select "NRX".
  - b) Click "Search NRX".
  - c) Click "Initialize".
  - d) Initialize the R&S NRVD base unit connected to the setup as "Meter2".



Use "Meter2" exclusively to connect the standards during measurements.

Additional Data ✕

NRVD

Expiry date of calibration and related certificate no.

e.g. '1998-03'      2027-11

Certificate No.      1020A300817792

---

POWER STANDARD	LINEARITY STANDARD
Expiry date of calibration and related certificate no.	
NRVC	
NRPC18    918024	NRPC-LS    900006
2026-06	2026-12
1020A300799666	1020A300819415
NRPC33    933001	
2026-07	
0001A300709031	
NRPC40    100186	
2026-07	
0001A300709489	
NRPC50    950003	
2026-02	
0001A300683456	
NRPC67    100475	
2026-02	
0001A300683474	

Please note :  
Update of  
NRPCxx data only  
after measurement  
has been set up

# 10 Data management

Depending on the origin and content, this description distinguishes between the following data types:

- Operational data
- Non-operational data

## Operational data (data for intended use)

The power sensor uses and creates this data because of its intended use and according to the settings and configuration you have made. Thus, this data makes up most of the data that the R&S NRPC creates, such as user files that contain user-defined configurations or data, like sensor settings or measurement data.

## Non-operational data (usage data)

The R&S NRPC creates this data during and through its use. Such data is collected e.g. for troubleshooting, to help our customer support center find solutions quickly.

The R&S NRPC generates this data continuously and in real-time. This data is saved on the power sensor. The power sensor is not capable of storing this data on a remote server.

The R&S NRPC generates the following data and saves it in the non-volatile memory:

- Diagnostic and troubleshooting data  
On demand, this data is returned as block data containing a compressed archive of files in text and binary format. The volume of the non-operational data depends on the usage of the product and typically amounts to about 20 kbyte.  
You can access, retrieve and delete this data. See [Section 12.3, "Collecting information for technical support"](#), on page 97.

The R&S NRPC generates the following data and saves it temporarily. When you disconnect the power sensor from its power source, this data is deleted.

- Environmental conditions  
You can access and retrieve this data using the `TEST:SENsOr?` command.
- Hardware component metadata  
You can access and retrieve this data using the `SYSTem:DFPPrint<Channel>?` command.

For additional information on the different memory types and on how to clear the internal memory to protect sensitive data, see the instrument security procedures document at:

[www.rohde-schwarz.com/manual/nrpc](http://www.rohde-schwarz.com/manual/nrpc)

# 11 Firmware update

- [Downloading the firmware update file](#).....92
- [Updating the firmware](#).....92

## 11.1 Downloading the firmware update file

### 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/nrpc](http://www.rohde-schwarz.com/firmware/nrpc)
2. Save the RSU file on the computer.
3. If the RSU file is packed in a \*.zip archive, extract it.

## 11.2 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 that needs to be sent in for maintenance.

You can choose from several methods to update the firmware installed on the sensor.



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 customer support to receive a special downgrade file for your sensor. See [Section 12.5, "Contacting customer support"](#), on page 99.

### 11.2.1 Using the Firmware Update program

The Firmware Update program is part of the R&S NRP-Toolkit. See also [Section 5.2.1, "R&S NRP-Toolkit"](#), on page 26.



You can use the Firmware Update program only if the sensor is recognized as a VISA device.

### To check the prerequisites

1. Ensure that a recent VISA software is installed on the computer.

The latest version is provided on the Rohde & Schwarz website at [www.rohde-schwarz.com/rsvisa](http://www.rohde-schwarz.com/rsvisa).

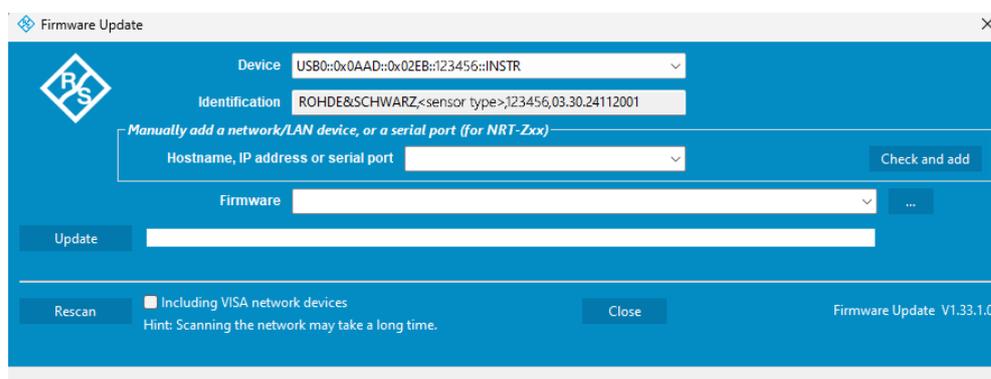
2. Ensure that the R&S NRP-Toolkit for Windows is installed on the computer. See [Section 5.2.1, "R&S NRP-Toolkit"](#), on page 26.

### To update the firmware over USB

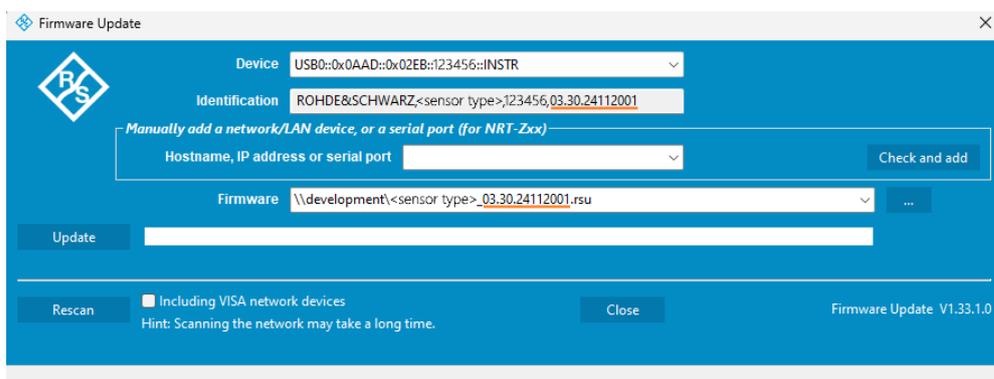
A firmware update can take up to 5 minutes. Ensure that the update is not interrupted.

1. Ensure that the prerequisites are fulfilled. See ["To check the prerequisites"](#) on page 92.
2. Connect the sensor to the computer.
3. Start the Firmware Update program:  
"Start" menu > "NRP-Toolkit" > "Firmware Update".

The program automatically starts scanning for R&S sensors connected via USB. When the scan is completed, all recognized sensors are listed under "Device".



4. If the sensor you want to update is not listed, perform one of the following actions:
  - Click "Rescan" to search for attached sensors.
  - 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 is accessible.
5. Under "Device", select the sensor you want to update.  
**Note:** The "Hostname, IP Address or Serial Port" field is not used during this procedure. Therefore, leave it empty.
6. Under "Firmware", enter the full path and filename of the update file. Alternatively, click  next to the field.
7. Click "Update".  
During the update process, a progress bar is displayed. The update sequence can take a couple of minutes, depending on the sensor model and the size of the selected file.
8. Check if the update was successful. The firmware version in the "Identification" field must match the version you selected in the "Firmware" field.



## 12 Troubleshooting

In this section, the troubleshooting for the R&S NRPC power standard and the R&S NRPCx-B1 verification sensor is described. For information on solving measurement problems, see [Section 6.3, "Troubleshooting measurement problems"](#), on page 51.

• <a href="#">Error messages</a> .....	95
• <a href="#">Performing a self-test</a> .....	95
• <a href="#">Collecting information for technical support</a> .....	97
• <a href="#">Sensor information</a> .....	97
• <a href="#">Contacting customer support</a> .....	99

### 12.1 Error messages

#### Querying errors (remote control)

In remote control, the commands querying errors are part of `SYSTem`.

The severity of the error is distinguished:

- Normal error  
Results from, for example, unknown commands or syntax errors and generally affect a single parameter or setting.
- Static error  
More severe than a normal error. Prevents the execution of normal measurements.

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

You can query the error queue using:

- `SYSTem:ERRor:ALL?`
- `SYSTem:ERRor:COUNT?`
- `SYSTem:ERRor[:NEXT]?`

If you want to look only at static errors, use:

- `SYSTem:SERRor?`
- `SYSTem:SERRor:LIST[:NEXT]?`

### 12.2 Performing a self-test

The self-test gives you detailed information that you can use for troubleshooting.

The R&S Recal+ software supports a self-test of the calibration kit so that you can run the self-test in the measurement setup. For details, see [Section 7.1, "Built-in self-test"](#), on page 60 or the R&S Recal+ help.



Do not apply a signal to the sensor while the self-test is running. If the self-test is carried out with a signal being present, error messages can erroneously be output for the following test steps:

- Offset Voltages

### Using remote control

- ▶ For a quick check, send:

`TEST:SENSor?`

For each test step, PASS or FAIL is listed.

#### Operating Voltages:

```
+3V3_VCC_MIO:      PASS (+3.31 V)
+1V8_PS:           PASS (+1.79 V)
+1V0_PS:           PASS (+0.99 V)
+3V3_VCC_13:      PASS (+3.31 V)
+2V5_VCC_34:      PASS (+2.51 V)
+1V8_VCC_35:      PASS (+1.80 V)
+1V8_PL:           PASS (+1.78 V)
+1V0_PL:           PASS (+1.00 V)
+1V8_LPDDR2_CORE: PASS (+1.80 V)
+1V2_LPDDR2:      PASS (+1.20 V)
+0V6_VREF_LPDDR2: PASS (+0.60 V)
+1V25_VREF:       PASS (+1.25 V)
+2V5_ANALOG:      PASS (+2.51 V)
-2V5_ANALOG:      PASS (-2.55 V)
VREF_ANALOG:      PASS (+4.096 V)
```

#### Temperatures:

```
Detector Temperature:    PASS (+25.5 deg C)
Analog Board Temperature: PASS (+29.9 deg C)
Digital Board Temperature: PASS (+45.9 deg C)
```

Offset Voltages: PASS (-0.0497 mV, -0.0498 mV)

Noise Voltage: FAIL (+8.64 uV)

Test Heater Power Drift: PASS (-0.07 %)

## 12.2.1 Interpreting the test results

If all test steps or parts pass, the overall result is PASS. If one test step or a part of it fails, the overall result is FAIL. What you need to do in this case is described in the following.

### Operating Voltages, Reference Voltages, Offset Voltages, Noise Voltage

Checks the voltages.

If the test fails:

1. Disconnect all signal sources and connectors except LAN or USB.

2. Perform the self-test again.  
If it fails again, a hardware defect is probable.
3. Contact the customer support.

### Temperatures

Checks the temperature at several measurement points, whether they are plausible and whether the limits are met.

Is the ambient temperature OK?

- ▶ Check whether the ambient temperature lies within the range rated in the specifications document of the R&S NRPC.

If the ambient temperature is higher or lower, adjust the air conditioning of the room or move the test setup into a room with a fitting temperature.

## 12.3 Collecting information for technical support

If you encounter problems that you cannot solve yourself, contact your Rohde & Schwarz support center, see [Section 12.5, "Contacting customer support"](#), on page 99. Our support center staff is optimally trained to assist you in solving problems.

The support center finds solutions more quickly and efficiently if you provide them with information on the instrument and an error description.

### Obtaining information from the sensor firmware

To create, collect and save the diagnostic and troubleshooting data, use the remote control. See [SYSTem:INFO:SUPPort?](#) on page 102.

Collect also the error information. See [Section 12.1, "Error messages"](#), on page 95.

Attach the collected information to an email in which you describe the problem.

If you need to transport or ship the product, see [Section 14, "Transporting"](#), on page 105.

## 12.4 Sensor information

### Device footprint

The device footprint contains information about the sensor hardware, the installed software, and license data.

```
#41905<?xml version="1.0" encoding="utf-8" ?>  
<DeviceFootprint formatVersion="03.05" creationDate="1970-01-01T00:00:07"
```

```

checksum="140271acac7f19bf2efd69cb559ff4fb">
<DeviceData deviceId="1418.1573.02-100753-Cd" partChangeIndex="--.--"
type="NRPC67" upgradeType="NRPC67" upgradePartNumber="1418.1573.02"
hostName="NRPC67-100753"/>
<HardwareData cpu="ARMv7 Processor rev 0 (v7l)" ramSize="129642496">
  <HardwareList>
    <Hardware id="12001" partNumber="1424.5719.02" sn="101369"
partName="ZE SENSORKOPF 67 GHZ NRPXXT"/>
    <Hardware id="12002" partNumber="1424.5725.00" sn="000000"
partName="BD DETEKTOR NRPXX" parentId="12001"/>
    <Hardware id="12003" partNumber="1419.0464.02" sn="106067"
partName="ED ANALOG BOARD NRP18T"/>
    <Hardware id="12004" partNumber="1419.0541.02" sn="128775"
partName="ED DIGITALBOARD NRPXXS"/>
    <Hardware id="12005" partNumber="1419.0529.02" sn="135048"
partName="ED INTERFACE BOARD"/>
  </HardwareList>
</HardwareData>
<SoftwareData>
  <Bios name="U-Boot" version="2013.01.01 (Oct 19 2021 - 17:34:26)"/>
  <OperatingSystem name="Linux - Linux Platform Kit 2.3.4-6 (pyro)"
version="2.3.4-6" imageName="Linux Platform Kit 2.3.4-6 (pyro)"
imageVersion="2.3.4-6" systemWordSize="32-Bit" systemLanguage="C"
kernelRelease="3.14.34"
kernelVersion="#1 SMP PREEMPT Thu Apr 13 17:17:00 UTC 2023"/>
  <SoftwareList>
    <Software name="RSU build" version="03.10.24022101.beta"
vendorName="Rohde&Schwarz"/>
    <Software name="SW build" version="24.02.21 19:26"
vendorName="Rohde&Schwarz"/>
    <Software name="FPGA image" version="1.0.6"
vendorName="Rohde&Schwarz"/>
  </SoftwareList>
</SoftwareData>
<LicenseData conformToTvr320="false">
  <ActiveLicenseList>
    <ActiveLicense type="NRPS-K1" partNumber="1419.0135.02"
keyCode="25c4efdfd70f74f86d0f011ac919823e"/>
  </ActiveLicenseList>
</LicenseData>
</DeviceFootprint>

```

## 12.5 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](http://www.rohde-schwarz.com/support), or follow this QR code:



*Figure 12-1: QR code to the Rohde & Schwarz support page*

# 13 Remote control

For general information on remote control of Rohde & Schwarz products via SCPI, refer to [www.rohde-schwarz.com/rc-via-scpi](http://www.rohde-schwarz.com/rc-via-scpi).

## 13.1 Remote control interfaces and protocols

For remote control, communication between the R&S NRPC power standard and the controlling host is established based on the USB interface and the USBTMC protocol.

The USB test & measurement class specification (USBTMC) is a protocol that is built on top of USB for communication with USB devices from the test & measurement category. It defines a dedicated class code that identifies a device's functionality. The device also uses this class code to identify itself as a member of the test & measurement class. Using a VISA library, such devices support service request, trigger and other operations that are commonly found in GPIB devices.

### Computer requirements

- VISA library  
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 USBTMC.  
VISA detects and configures the product automatically when the USB connection is established.
- USBTMC driver  
Apart from the USBTMC driver, which comes with the installation of VISA, you do not have to install a separate driver.

### USB resource string

The VISA resource string for USBTMC device communication represents an addressing scheme that is used to establish a communication session with the product. It is based on the product address and some product- and vendor-specific information. The syntax of the used USB resource string is:

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

- <vendor ID> is the vendor ID for Rohde & Schwarz, 0x0AAD.
- <product ID> is the product ID for the product.
- <serial number> is the individual serial number of the product, printed on the casing.

### Example:

```
USB0::0x0AAD::0x01A5::100001::INSTR
```

0x0AAD is the vendor ID for Rohde & Schwarz.

0x01A5 is the product ID.

100001 is the serial number of the product.

**Table 13-1: Power standard USB product IDs**

R&S NRPC	Model	USB product ID
R&S NRPC18	02	0x00BF
	03	0x01B6
R&S NRPC33	02	0x00B6
	03	0x01B7
R&S NRPC40	02	0x008F
	03	0x01B8
R&S NRPC50	02	0x0090
	03	0x01B9
R&S NRPC67	02	0x01A5

For distinguishing models, see [Section 3.4, "Recognizing power standard models"](#), on page 18.

**Table 13-2: Verification sensor USB product IDs**

R&S NRPCx-B1	Model	USB product ID
R&S NRPC18-B1	03	0x00C1
	04	0x01B2
R&S NRPC33-B1	02	0x00C2
	03	0x01B3
R&S NRPC40-B1	03	0x00C3
	04	0x01B4
R&S NRPC50-B1	02	0x00C4
	03	0x01B5
R&S NRPC67-B1	02	0x01A6

For distinguishing models, see [Section 3.4, "Recognizing power standard models"](#), on page 18.

## 13.2 Remote commands for troubleshooting

TEST:SENSor?	102
*TST?	102
SYSTem:DFPRint<Channel>?	102
SYSTem:INFO:SUPPort?	102
SYSTem:ERRor:ALL?	102
SYSTem:ERRor:COUNT?	103
SYSTem:ERRor[:NEXT]?	103
SYSTem:SERRor?	103
SYSTem:SERRor:LIST[:NEXT]?	103

---

**TEST:SENSor?** [<Item>]

Starts a self-test of the sensor.

In contrast to **\*TST?**, this command returns detailed information that you can use for troubleshooting. If one test step or a part of it fails, the overall result is FAIL.

**Query parameters:**

<Item>                      String

**Usage:**                      Query only

---

**\*TST?**

Self-test

Triggers a self-test of the sensor and outputs the result. 0 indicates that no errors have occurred.

**Usage:**                      Query only

---

**SYSTem:DFPRint<Channel>?**

Queries the current device footprint.

**Suffix:**

<Channel>                      1...4  
Measurement channel if more than one channel is available.

**Usage:**                      Query only

---

**SYSTem:INFO:SUPPort?**

Queries the diagnostic and troubleshooting data. Returns the results as a definite length-arbitrary block data containing a compressed archive (.tar.gz) of the diagnostic and troubleshooting data in the following format:

- #
- Single digit indicating how many digits follow to specify the size of the compressed archive.
- Number that specifies the size of the compressed archive.
- Compressed archive data
- 0x0a as appended delimiter (single '\n' character) for line feed

See also [Section 12.3, "Collecting information for technical support"](#), on page 97.

**Usage:**                      Query only

---

**SYSTem:ERRor:ALL?**

Queries all unread entries in the SCPI communication error queue and removes them from the queue.

Returns a comma-separated list of error numbers and a short error description in the first-in first-out order.

**Example:**            `SYST:ERR:ALL?`  
                           Query  
                           `0, "No error"`  
                           Response

**Usage:**             Query only

---

#### **SYSTem:ERRor:COUNT?**

Queries the number of entries in the SCPI communication error queue.

**Example:**            `SYST:ERR:COUN?`  
                           Query  
                           `1`  
                           Response: One error has occurred since the error queue was last read out.

**Usage:**             Query only

---

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

Queries the SCPI communication error queue for the oldest entry and removes it from the queue.

Returns an error number and a short description of the error.

**Example:**            `SYST:ERR?`  
                           Query  
                           `0, 'no error'`  
                           Response: No errors have occurred since the error queue was last read out.

**Usage:**             Query only

---

#### **SYSTem:SERRor?**

Queries the next static error, if available.

Static errors, as a rule, prevent the execution of normal measurements.

Errors in SCPI communication are queried using `SYSTem:ERRor[:NEXT]?`.

**Usage:**             Query only

---

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

Queries the list of static error changes for the oldest entry and removes it from the queue.

Returns an error number and a short description of the error.

**Example:**           SYST:SErr:LIST?  
                  Query  
                  0,"reported at uptime:2942; notice;  
                  auto-averaging exceeded maximum time;  
                  Notification"  
                  Response

**Usage:**            Query only

# 14 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 15000 m above sea level.

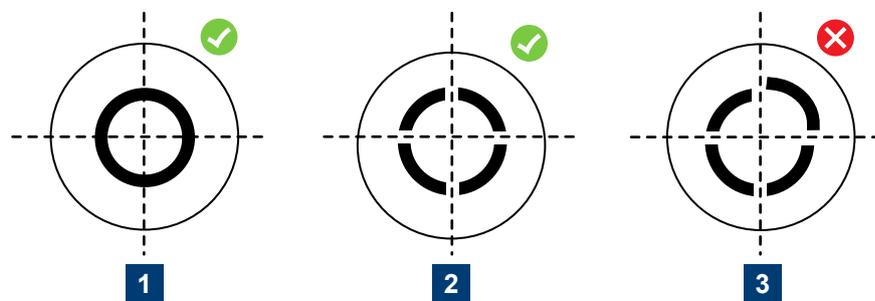
# 15 Maintenance, storage and disposal

Verify the power standard with the verification set before usage or daily. See [Section 7, "Verification"](#), on page 60.

## 15.1 Checking the RF connector

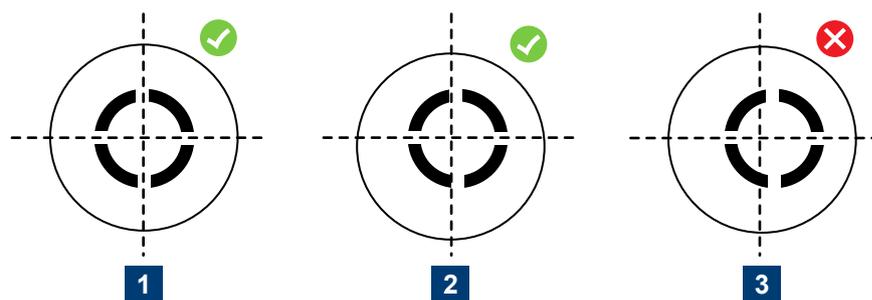
If the product is used frequently, check the RF connectors for visible damage - bent inner conductors, broken contact springs and so on. If the RF connectors are damaged, stop using the product. Contact Rohde & Schwarz customer support, see [Section 12.5, "Contacting customer support"](#), on page 99.

### Checking the integrity of the RF connector



- 1 = Perfectly formed contacts
- 2 = Normal wear
- 3 = Damaged contacts

### Checking the concentricity of the RF connector



- 1 = Perfectly concentric
- 2 = Slightly off-center
- 3 = Excessively off-center

## 15.2 Exchanging the test port RF connector

In the R&S NRPC33, R&S NRPC40, R&S NRPC50 and R&S NRPC67 power standards, there is an adapter between the test port and the output of the integrated power splitter. You can exchange the adapter if the RF connector of the test port becomes worn out. A replacement adapter is supplied for this purpose with each of the calibration kits mentioned here. The accuracy level is ensured even after the adapter is exchanged. Each power standard is calibrated with both adapters during manufacture and recalibration at German Accreditation Body (DKD) laboratory D-K-15195-01-01. The calibration certificate contains the calibration data for both configurations.

Exchange the adapter if the test port is damaged or in the following cases:

- Verification with the R&S NRPCx-B1 verification sensor fails due to strong oscillations in the frequency response.
- High dependence on the angular position during calibration of absolute accuracy.

### To exchange the test port RF connector

1. Remove the anti-turn device for the union nut of the adapter:
  - a) Loosen the two grub screws using an Allen wrench with a 0.9 mm wrench opening.
2. Unscrew the adapter using a flat wrench with an 8 mm wrench opening.
3. Screw on the replacement adapter, tighten the union nut with a torque of 1.5 Nm, using a torque flat wrench with an 8 mm wrench opening.

**Note:** The torque of the supplied torque wrench (0.9 Nm) is too small to prevent the adapter from turning during subsequent usage. If a suitable torque wrench is not available, tighten the adapter by feeling and then check whether the adapter turns when the sensor is screwed on and off.
4. Slide on the anti-turn device and tighten the grub screws.
5. Install the R&S NRP-Toolkit software, provided on the CD-ROM.
6. Connect the power standard to the USB port of a Windows computer. Requires an R&S NRP-Z3 or R&S NRP-Z4 USB adapter or an R&S NRP-Z5 sensor hub.
7. Load the calibration data set of the power standard for the replacement adapter using the S-Parameter Update Multi program module of the R&S NRP-Toolkit. See ["To load the calibration data set of the power standard"](#) on page 108.
8. Connect the verification sensor to the USB port of a Windows computer.
9. Load the calibration data set for the verification sensor to use on a power standard with the replacement adapter. Use the S-Parameter Update Multi program module of the R&S NRP-Toolkit.

Also exchange the calibration data set for the verification sensor to obtain correct verification results from the start. The calibration data set is called `Caldata_NRPC-B1_T<serial no.>.bin` and is also available on the CD-ROM

in the `Dataset/Exchange_Thru` directory. As before, the serial number at the end of the filename refers to the spare adapter.

10. Connect power standard and verification sensor to R&S NRX base unit.
11. Check identification of the loaded calibration data sets.

After successfully loading the calibration data sets, the serial number of the spare adapter is displayed in info texts of the R&S NRX base unit ("System" > "Sensor Info: SPD Mnemonic").

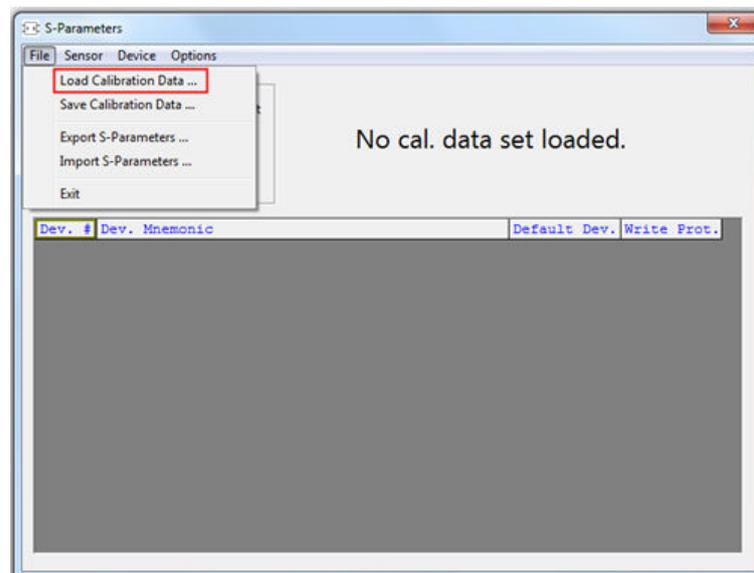
For the power standard, the letter "T" is followed by the serial number engraved on the spare adapter, e.g. 12387 in the entry T12387. An additional code "A#####" stands for the supplied reference attenuator of the R&S NRPC33 and R&S NRPC40 power standards.

12. Perform a verification measurement. See [Section 7.1, "Built-in self-test"](#), on page 60.  
The measured values must lie well within the specified tolerance bands. If not, do the following:
  - a) Check whether the correct calibration data sets were loaded.
  - b) Unscrew the adapter and try remounting it in a different angular position.

#### To load the calibration data set of the power standard

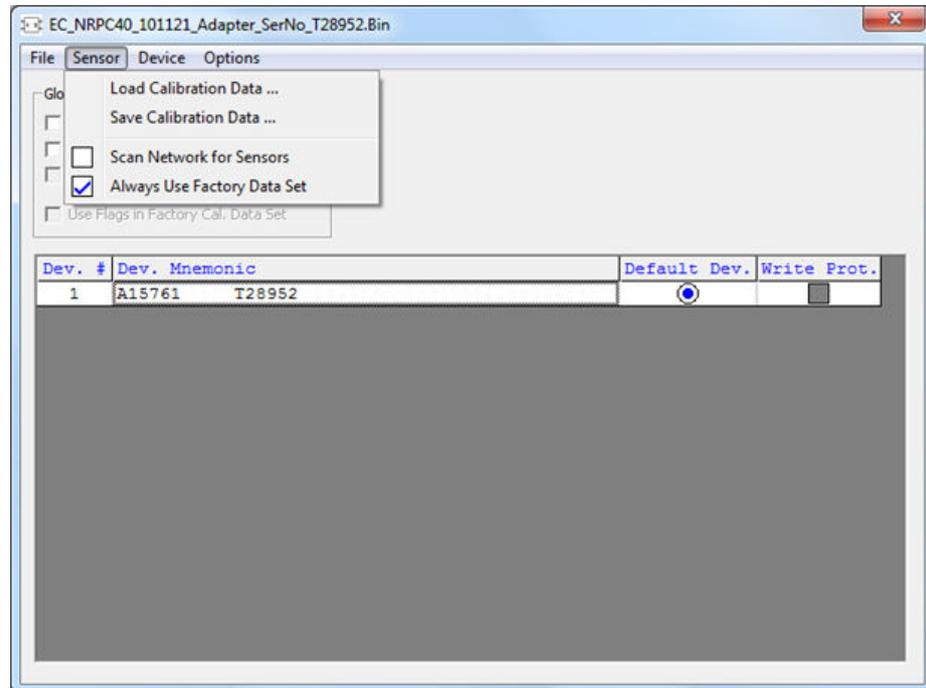
Exchange the calibration data for the power standard when you change the adapter. The data set called `Caldata_NRPC_T<serial no.>.bin` is located on the data CD-ROM in the `Dataset/Exchange_Thru` directory. The serial number at the end of the filename refers to the spare adapter. This number is also engraved on the adapter.

1. Open the S-Parameter Update Multi program module of the R&S NRP-Toolkit.



2. Under "File", select "Load Calibration Data". The calibration data for the power standard are in the above-named directory.

- Under "Sensor", enable "Always Use Factory Data Set", if not already enabled.



## 15.3 Recalibration

We recommend returning the R&S NRPC and its options to Rohde & Schwarz for recalibration once a year. As part of recalibration, all components are checked, and the reference standards, the reference attenuators and the precision termination are recalibrated. The sensors from the verification set are adjusted to match the recalibrated standards and the data memories are updated.

### How to get the recalibration done?

- Contact your nearest Rohde & Schwarz representative. See [Section 12.5, "Contacting customer support"](#), on page 99.
- Send in the complete calibration kit packed in its storage cases. See also ["Packing"](#) on page 105.

### What to do when the recalibrated calibration kit comes back?

When you receive the calibrated kit, perform the following steps to ensure that it is functioning correctly.

- If mentioned in the accompanying letter, update the R&S Recal+ software. For details, see the release note of the R&S Recal+ software.
- Connect the R&S NRPC power standard to one channel of the R&S NRX.
- Start the R&S Recal+ calibration software.

4. Initialize the R&S NRX.
5. Perform the verification as described in [Section 7, "Verification"](#), on page 60.

## 15.4 Cleaning

- ▶ Clean the outside of the product 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 70% isopropyl alcohol instead of water, be careful not to damage the labeling. Do not use cleaning agents that can damage the instrument such as acetone, acids or alkalis.

Further information:

- Application note [1MA99](#): "Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment"

## 15.5 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.

## 15.6 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 15-1: 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.

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