Operating Manual

Average Power Sensor

R&S® NRP-Z92

1171.7005.02
1171.7005.42

Printed in Germany

ROHDE&SCHWARZ
Test and Measurement

Dear Customer,

Grouped Safety Messages

Make sure to read through and observe the following safety instructions!

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standard of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, the Rohde & Schwarz group of companies will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or, if expressly permitted, also in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.

Symbols and safety labels

							
Observe product documentation	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

					
Supply voltage ON/OFF	Standby indication	Direct current (DC)	Alternating current (AC)	Direct/alternating current (DC/AC)	Device fully protected by double/reinforced insulation

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories.

Tags and their meaning

DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	NOTICE indicates a property damage message. In the product documentation, the word ATTENTION is used synonymously.

These tags are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the tags described here are always used only in connection with the related product documentation and the related product. The use of tags in connection with unrelated products or documentation can result in misinterpretation and thus contribute to personal injury or material damage.

Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
   prescribed operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude 2000 m above sea level, max. transport altitude 4500 m above sea level.
   A tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.
2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the product must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test).
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens, e.g. nickel) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.
4. If products/components are mechanically and/or thermically processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled, e.g. for disposal purposes, by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

5. If handling the product yields hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation.
6. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer/operator is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.
7. Operating the products requires special training and intense concentration. Make certain that persons who use the products are physically, mentally and emotionally fit enough to handle operating the products; otherwise injuries or material damage may occur. It is the responsibility of the employer to select suitable personnel for operating the products.
8. Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
9. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with earthing contact and protective earth connection.
10. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
11. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.
12. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.
13. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
14. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, this can result in sparks, fire and/or injuries.
15. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
16. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
17. Ensure that the connections with information technology equipment comply with IEC 950/EN 60950.
18. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
19. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a license electrician.

20. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that suitable protection is provided for users and products.
21. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.
22. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.
23. Rohde & Schwarz products are not protected against penetration of liquids, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock for the user or damage to the product, which can also lead to personal injury.
24. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.
25. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.
26. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.
27. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. Do not short-circuit batteries and storage batteries.
    If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries must be recycled and kept separate from residual waste. Batteries and storage batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.
28. Please be aware that in the event of a fire, toxic substances (gases, liquids etc.) that may be hazardous to your health may escape from the product.
29. The product can be very heavy. Be careful when moving it to avoid back or other physical injuries.
30. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves).
31. Handles on the products are designed exclusively for personnel to hold or carry the product. It is therefore not permissible to use handles for fastening the product to or on means of transport such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport and for observing the safety regulations of the manufacturer of the means of transport. Noncompliance can result in personal injury or material damage.
32. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. The driver is always responsible for the safety of the vehicle. The manufacturer assumes no responsibility for accidents or collisions.
33. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the product documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.
34. Prior to cleaning, disconnect the product from the AC supply. Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluent for cellulose lacquers.

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EC Certificate of Conformity

CE

Certificate No.: 2002-36, page 1

This is to certify that:

Equipment type	Stock No.	Designation
NRP	1143.8500.02	Power Meter
NRP-B1	1146.9008.02	Sensor Check Source
NRP-B2	1146.8801.02	Second Sensor Input
NRP-B3	1146.8501.02	Battery Supply
NRP-B4	1146.9308.02	Ethernet Lan-Interface
NRP-B5	1146.9608.02	3rd und 4th Sensor
NRP-B6	1146.9908.02	Rear-Panel Sensor

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)
- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 2001-12
EN55011 : 1998 + A1 : 1999 + A2 : 2002, Class B
EN61326 : 1997 + A1 : 1998 + A2 : 2001 + A3 : 2003

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 2002

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 2008-07-02

Central Quality Management FS-QZ / Radde

ROHDE&SCHWARZ
EC Certificate of Conformity

CE

Certificate No.: 2002-36, page 2

This is to certify that:

Equipment type	Stock No.	Designation
NRP-Z3	1146.7005.02	USB Adapter
NRP-Z4	1146.8001.02/.04	USB Adapter
NRP-Z11	1138.3004.02/.04	Average Power Sensor
NRP-Z21	1137.6000.02	Average Power Sensor
NRP-Z22	1137.7506.02	Average Power Sensor
NRP-Z23	1137.8002.02	Average Power Sensor
NRP-Z24	1137.8502.02	Average Power Sensor
NRP-Z27	1169.4102.02	Power Sensor Module
NRP-Z28	1170.8008.02	Level Control Sensor
NRP-Z37	1169.3206.02	Power Sensor Module
NRP-Z51	1138.0005.02	Thermal Power Sensor
NRP-Z52	1138.0505.18	Thermal Power Sensor
NRP-Z55	1138.2008.02	Thermal Power Sensor
NRP-Z81	1137.9009.02	Wideband Power Sensor
NRP-Z91	1168.8004.02/.04	Average Power Sensor
NRP-Z92	1171.7005.02/.42	Average Power Sensor
NRP-Z98	1170.8508.02	Level Control Sensor
NRP-Z311	1171.8601.02	Average Power Sensor

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)

- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 2001-12
EN55011 : 1998 + A1 : 1999 + A2 : 2002, Class B
EN61326 : 1997 + A1 : 1998 + A2 : 2001 + A3 : 2003

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 2002

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 2008-07-02

Central Quality Management FS-QZ / Radde

QUALITÄTSZERTIFIKAT

Sehr geehrter Kunde,
Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Managementsystems entwickelt, gefertigt und geprüft.
Das Rohde & Schwarz Managementsystem ist zertifiziert nach:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

CERTIFICATE OF QUALITY

Dear Customer,
you have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

CERTIFICAT DE QUALITÉ

Cher Client,
vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément aux normes:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

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1171.0200.11-03.00

PD 5213.8744.99 · V 01.00 · May 2007

Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish. We will take care that you will get the right information.

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* 0.14 €/Min within the German fixed-line telephone network, varying prices for the mobile telephone network and in different countries.

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1171.0200.22-03.00

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- Sales Locations
- Service Locations
- National Websites

Contents

1 Putting into Operation 1.1

Unpacking the power sensor 1.1

Connecting the power sensor 1.1

Operation with the R&S NRP power meter 1.2

Connecting the power sensor 1.2

PC control 1.3

Hardware and software requirements 1.3

Operation via the R&S NRP-Z4 passive USB adapter 1.5

Connecting the sensor to the DUT 1.5

Operation via the R&S NRP-Z3 active USB adapter 1.5

Operation with other Rohde & Schwarz test instruments 1.7

Hardware and software requirements 1.7

Figures

Fig. 1-1 Displaying the total available power of a USB port....1.4
Fig. 1-2 Configuration with R&S NRP-Z4 passive USB adapter....1.5
Fig. 1-3 Configuration with R&S NRP-Z3 active USB adapter....1.6
Fig. 1-4 Changing the primary adapter....1.6

Tables

Table 1-1 Sensor operating modes and their characteristics....1.2
Table 1-2 Sensor operating modes with corresponding settings in the Offset dialog....1.3
Table 1-3 Overview of the R&S instruments that support power measurements using R&S NRP power sensors....1.7

1 Putting into Operation

NOTICE *Follow the instructions below precisely to prevent damage to the sensor – particularly when you are putting it into operation for the first time.*

Unpacking the power sensor

Remove the power sensor from its packing and check that nothing is missing. Inspect all items for damage. If you discover any damage, inform the carrier responsible immediately and keep the packing to support any claims for compensation.

It is also best to use the original packing if the power sensor is to be shipped or transported at a later date.

The power sensor contains components which can be destroyed by electrostatic discharges. To prevent this from happening, never touch the inner conductor of the RF connector and never open the power sensor.

Connecting the power sensor

NOTICE *To prevent EMI, the sensor must never be operated with its enclosure wholly or partially removed. Only use shielded cables that meet the relevant EMC standards.*

Never exceed the maximum RF power limit. Even brief overloads can destroy the sensor.

In many cases, the RF connector only requires manual tightening. However, for maximal measurement accuracy, the RF connector must be tightened using a torque wrench with a nominal torque of 1.36 Nm (12" lbs.).

Operation with the R&S NRP power meter

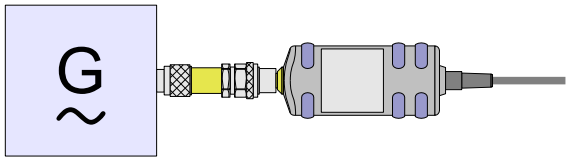
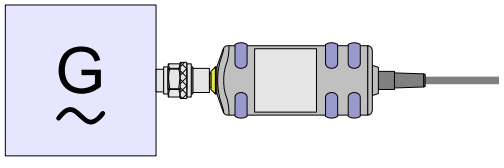
Connecting the power sensor

The power sensor can be connected to the R&S NRP base unit when it is in operation. The multiple circular plug-in connector must be inserted, red marking upwards, into one of the R&S NRP base unit's sensor connectors. When the power sensor is connected, it is detected by the R&S NRP base unit and initialized.

The R&S NRP-Z92 power sensor is fitted with a male N connector for connection to all common female N connectors. Using light pressure, and keeping the male N connector perpendicular, insert it into the female N connector and tighten the N connector locking nut (right-hand thread).

Unlike other power sensors, the R&S NRP-Z92 sensor can be operated in two configurations which have different power measurement ranges:

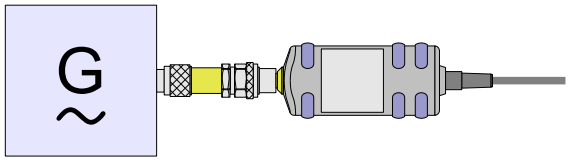
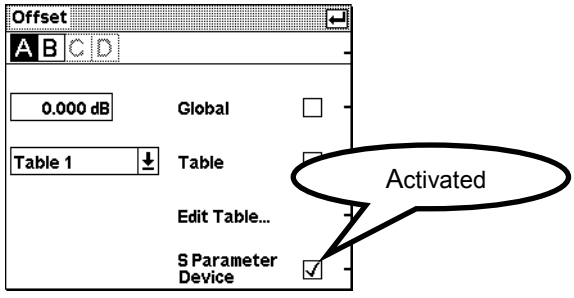
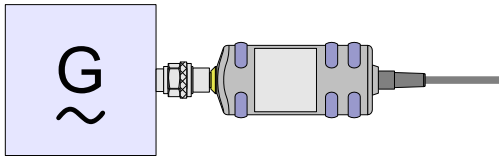
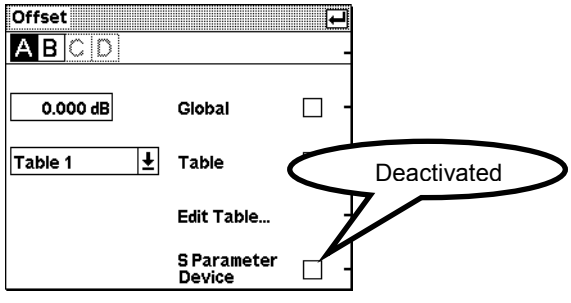
Table 1-1 Sensor operating modes and their characteristics

Sensor configuration	**Characteristics**	
Standard (with associated attenuator) Signal source R&S NRP-Z92 	Frequency range	9 kHz to 6 GHz
	Power measurement range	**2 nW to 2 W** (–57 dBm to +33 dBm)
	Maximum input power	**Max. 3 W (+35 dBm) avg** **Max. 10 W (+40 dBm) pk (<10 µs)**
	Other specifications	See data sheet/TI for R&S NRP-Z92
Sensitive (without attenuator) Signal source R&S NRP-Z92 (power sensor only) 	Frequency range	9 kHz to 6 GHz
	Power measurement range	**200 pW to 200 mW** (–67 dBm to +23 dBm)
	Maximum input power	**Max. 400 mW (+26 dBm) avg** **Max. 1 W (+30 dBm) pk (<10 µs)**
	Other specifications	See data sheet/TI for R&S NRP-Z91

In the standard configurations, the specifications given on the type plate are applicable to the sensor. In the configuration without the 10 dB attenuator, the R&S NRP-Z92 power sensor is 10 times more sensitive but has a lower maximum input power (see table). With the same level of accuracy, it is therefore identical to a R&S NRP-Z91 sensor.

The R&S NRP base unit is always set to the standard configuration when the sensor is connected or after the base unit is switched on with the sensor connected. If the sensor is operated without an attenuator, the R&S NRP power meter must be informed of this. This is done by deactivating the ***S Parameter Device*** option in the ***Offset*** dialog box each time the sensor is connected or each time the R&S NRP power meter is switched on. This option contains the S parameter data set for the attenuator connected upstream of the power sensor. The corresponding command must be used in remote-controlled systems.

Table 1-2 Sensor operating modes with corresponding settings in the Offset dialog

Sensor configuration	**Setting in the Offset dialog**
Standard (with associated attenuator) Signal source R&S NRP-Z92 	S-parameter correction activated (automatically after the R&S NRP is switched on or the sensor is plugged in) 
Sensitive (without attenuator) Signal source R&S NRP-Z92 (power sensor only) 	S-parameter correction deactivated (must be deactivated each time the R&S NRP is switched on or the sensor is plugged in) 

Installation and removal of the attenuator is described in detail in section 4.

PC control

Hardware and software requirements

The following requirements must be met if the power sensor is to be controlled by a PC via an interface adapter:

- The PC must have a USB port.
- The PC's operating system must support the USB port. This is the case with Windows™ 98, Windows™ ME, Windows™ 2000, Windows™ XP and more recent versions of the Windows™ operating system.
- The USB device drivers in the supplied ***R&S NRP Toolkit*** software package must be installed.

If these requirements are met, the power sensor can be controlled using a suitable application program such as the ***R&S NrpFlashup*** program contained in the ***R&S NRP Toolkit*** (includes the modules Power Viewer, USB Terminal, Firmware Update and Update S-Parameters).

When you insert the CD-ROM supplied with the R&S NRP, the ***R&S NRP Toolkit*** is automatically installed on your PC. The rest of the procedure is self-explanatory.

The power sensor can be powered in two ways:

- *Self-powered* from a separate power supply via the R&S NRP-Z3 active USB adapter.
- *Bus-powered* from the PC or a USB hub with its own power supply (*self-powered hub*) via the R&S NRP-Z3 active USB adapter or via the R&S NRP-Z4 passive USB adapter.

As the power sensor is a *high-power device*, there is no guarantee that it can be powered from all types of laptop or notebook in the *bus-powered* mode. To be sure, you should determine the current at the USB connectors beforehand:

- *In the Windows™ start menu, select* ***Settings – Control Panel***
- *Select the* ***System*** *icon*
- *Select the* ***Hardware*** *tab*
- *By clicking on the button with that name, start the* ***Device Manager***
- *Open* ***USB Controller*** *(all USB controllers, hubs and USB devices are listed here)*
- *Double-click on* ***USB Root Hub*** *or select* ***Properties*** in the context menu *(use the right-hand mouse button)*
- *Select the* ***Power*** *tab (Fig. 1-1). If the hub is self-powered and the total power available is, as indicated by* ***Hub Information,*** *500 mA per port, high-power devices can be connected.*

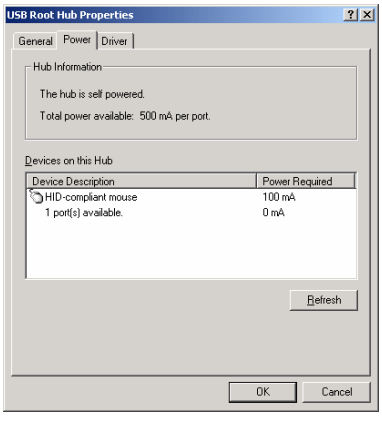


Fig. 1-1 Displaying the total available power of a USB port

If you have any doubts, ask the manufacturer if the USB port on your laptop or notebook can handle *high-power devices*.

Operation via the R&S NRP-Z4 passive USB adapter

Fig. 1-2 is a schematic of the measurement setup. The order in which the cables are connected is not critical.

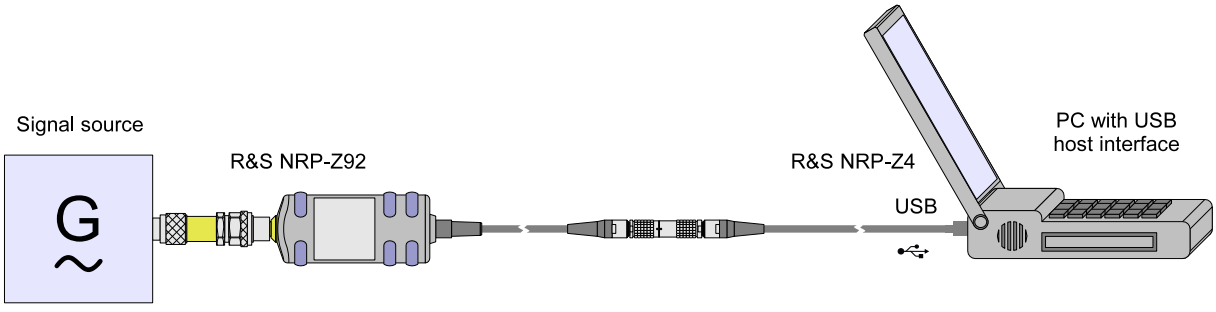


Fig. 1-2 Configuration with R&S NRP-Z4 passive USB adapter

Connecting the sensor to the DUT

The R&S NRP-Z92 power sensor is usually operated in combination with the attenuator supplied with the equipment. (Operation without attenuator or with another connected component is also possible, see part 3 of this user manual.) Both the power sensor and the attenuator are fitted with a male N connector for connection to all common female N connectors. Using light pressure, and keeping the male N connector perpendicular, insert it into the female N connector and tighten the N connector locking nut (right-hand thread). Connect first the sensor to the attenuator and then screw the male N connector of the attenuator on the DUT.

NOTICE *The test limits specified on the type label apply only if the supplied attenuator is used. For operation without attenuator, lower test limits apply (see data sheet).*

If the sensor is to be operated without an attenuator, S-parameter correction is to be switched off with the command *SENSe:CORRection:SPDevice:STATe OFF* (not possible in conjunction with the **Power Viewer** program module).

Operation via the R&S NRP-Z3 active USB adapter

Fig. 1-3 shows the configuration with the R&S NRP-Z3 active USB adapter, which also makes it possible to feed in a trigger signal for the *Timeslot* and *Trace* modes. The order in which the cables are connected is not critical.

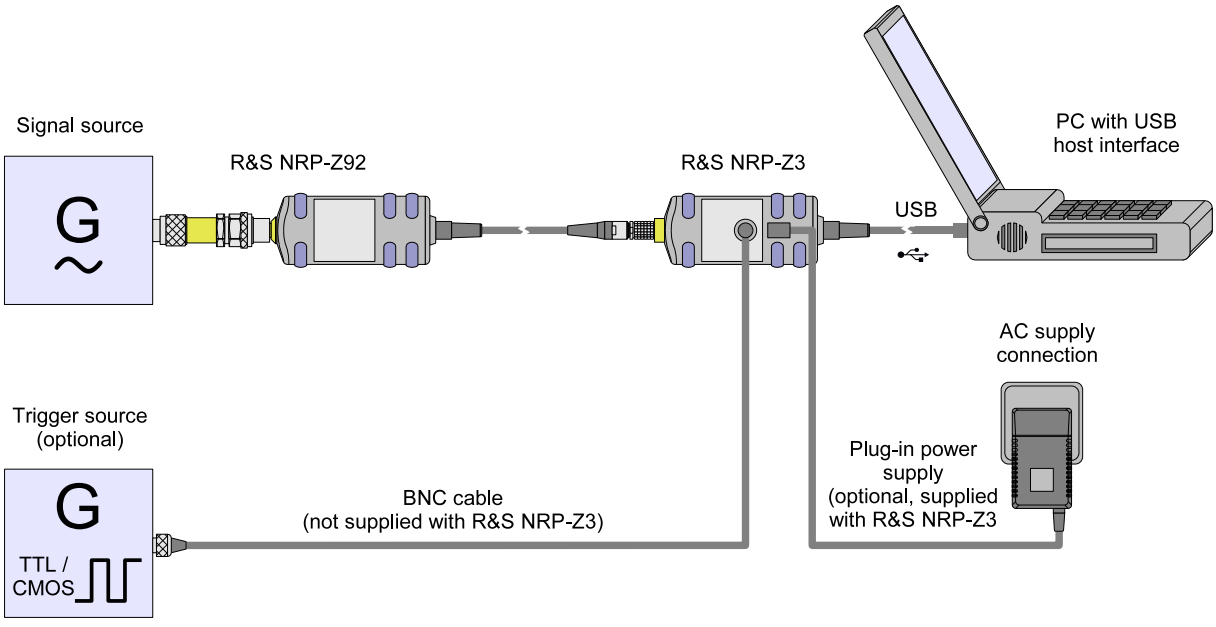


Fig. 1-3 Configuration with R&S NRP-Z3 active USB adapter

The plug-in power supply for the R&S NRP-Z3 can be powered from a single-phase AC source with a nominal voltage range of 100 V to 240 V and a nominal frequency between 50 Hz and 60 Hz. The plug-in power supply autosets to the applied AC voltage. No manual voltage selection is required.

The plug-in power supply comes with four primary adapters for Europe, the UK, the USA and Australia. No tools of any kind are required to change the primary adapter. The adapter is pulled out manually and another adapter inserted until it locks (Fig. 1-4).

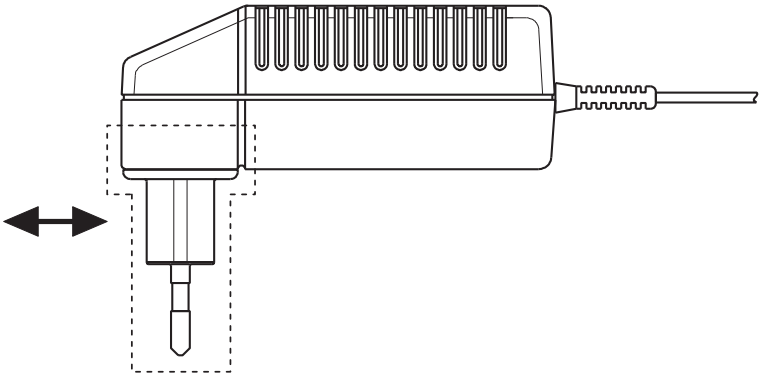


Fig. 1-4 Changing the primary adapter

The plug-in power supply is short-circuit-proof and has an internal fuse. It is not possible to replace this fuse or open the plug-in power supply.

NOTICE *The plug-in power supply is not intended for outdoor use.*

Keep within the temperature range of 0 °C to 50 °C.

If there is any condensation on the plug-in power supply, dry it off before connecting it to the AC supply.

Operation with other Rohde & Schwarz test instruments

Hardware and software requirements

Many Rohde & Schwarz test instruments allow power measurements using power sensors of the R&S NRP-Zxx series. The power sensors are generally connected to the USB ports of the test instrument via one of the two interface adapters, R&S NRP-Z3 or R&S NRP-Z4. On some instruments, such as the R&S SMU signal generator, there is also an R&S NRP sensor connector available for a direct connection. The following table gives an overview of the connection possibilities and the required options for power measurements using R&S NRP sensors:

Table 1-3 Overview of the Rohde & Schwarz instruments that support power measurements using R&S NRP power sensors

Instrument class	Type	Measure-ment channels	Options		Connectors	
			SW	HW	NRP-specific	Standard USB
Signal generators	SMA100A	1	---	---	1	2
	SMU200A	2	---	---	1	3
	SMJ200A	2	---	---	1	3
	SMATE200A	2	---	---	---	2
	SMF100A	2	---	---	1	2
Spectrum and signal analyzers	FSL	1	FSL-K9	---	---	2
				FSL-B5	1	2
	FSP	1	FS-K9	---	---	2
	FSU, FSUP, FSQ	1	FS-K9	---	---	2
	FSMR	1	---	---	1	2
Network analyzers	ZVA	4	---	---	---	4
	ZVB	4	---	---	---	4
	ZVL	1	ZVL-K1 FSL-K9	---	---	2
				FSL-B5	1	2

Table of Contents

2 Virtual Power Meter 2.1

Overview 2.1

Menus 2.3

Figs.

Fig. 2-1 **Power Viewer** virtual power meter 2.1

Tables

Table 2-1 Virtual power meter keys 2.2
Table 2-2 Virtual power meter entry fields 2.2

2 Virtual Power Meter

You will find the **NrpFlashup** program that enables you to operate the power sensor with a PC under Windows™ on the CD-ROM that accompanies the power sensor. The program comprises several modules which can be started centrally via the Windows™ start-menu entry **NRP Toolkit**.

This section describes the **Power Viewer** program module. This is a virtual power meter which only uses a cut-down set of the power sensor's functions. This means that after an extremely brief familiarization period, you can perform measurements.

The other modules in **NrpFlashup** are described in Chapter 3 of the operating manual (**Terminal** and **Update S-Parameters** modules) or in the service manual (**Firmware Update** module).

Overview

Start the virtual power meter using the **NRP Toolkit** – **Power Viewer** start-menu entry. The **Power Viewer** program window is displayed (Fig. 2-1).

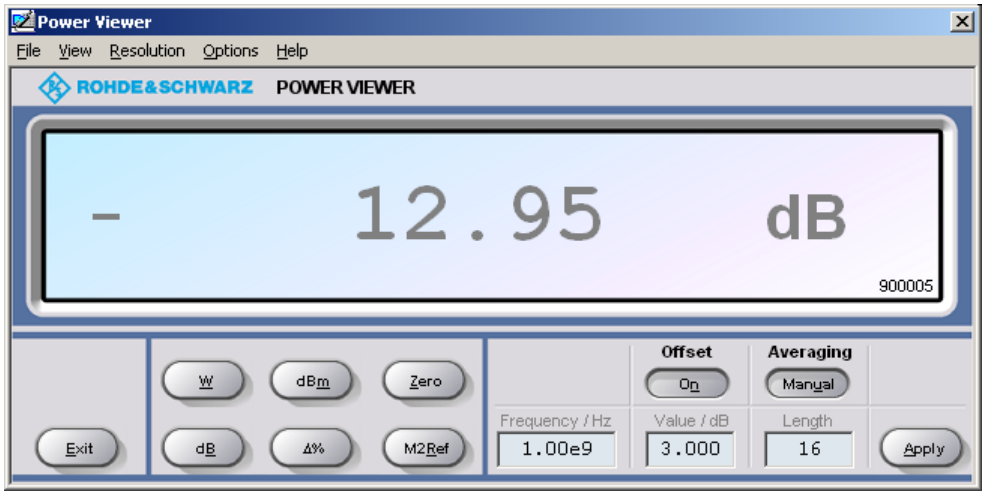


Fig. 2-1 **Power Viewer –** virtual power meter

The result display occupies most of the program window. The result, unit and additional power sensor status information are displayed. The serial number is displayed in the bottom right. The program window also contains animated buttons and entry fields (see Table 2-1 and Table 2-2).

Table 2-1 Virtual power meter keys

Button	Function	Key combination
Exit	Terminates the program. The current settings are saved and recalled the next time the program is started.	Alt + E
W	Selects Watt as the display unit.	Alt + W
dBm	Selects dBm as the display unit.	Alt + M
Zero	Zeroes the power sensor.	Alt + Z
dB	Selects dB as the display unit. This is the log of the ratio of the measured value to the reference value.	Alt + B
Δ%	Selects % as the display unit. The difference between the measured value and the reference value is expressed as a percentage.	Alt + %
M2Ref	Makes the current measured value the reference value for the relative display units dB and %.	Alt + R
Offset On/Off	Turns the global offset correction for the power sensor on or off. If the offset correction is Off, the **Offset/dB** entry field has a grey background.	Alt + N
Averaging Man/Auto	Turns auto-averaging on or off. When auto-averaging is on, the **Length** entry field has a grey background; the current averaging factor is displayed.	Alt + T
Apply	Accepts edited numerical values in the **Frequency/Hz**, **Value/dB** and **Length** entry fields and transfers them to the sensor.	Alt + A or Enter key

Table 2-2 Virtual power meter entry fields

Entry field	Function
Frequency/Hz	Frequency of the RF carrier in Hertz.
Value/dB	Attenuation in dB of the component connected to the power sensor. The valid range is –100 to 100. The global offset correction must be activated beforehand with the **Offset On/Off** button if this entry field is to be edited.
Length	Length of the averaging filter (= averaging factor). The valid range is 1 to 65536. Averaging must be set to manual with the **Averaging Man/Auto** button if this entry field is to be edited.

Scientific notation can also be used for the entry fields. If an invalid entry is made, an error message is output. An edited numerical value will not be transferred to the sensor unless you use the **Apply** button or the Enter key to terminate the entry.

Menus

The menu bar can be used to call less frequently used functions.

File

Start Log ...

Opens a file-selection dialog to specify the path and name of the log file. Clicking the **Save** button starts the recording. All displayed values are written line-by-line to the log file with the date (format: YY/MM/DD) and time (format: hh:mm:ss.ms). Example:

```
-22.51 dBm (03/02/25 15:37:25.310)
```

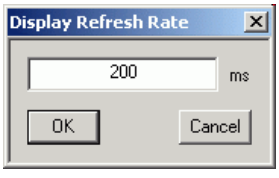
Stop Log

Ends the log-file recording.

View

Display Refresh Rate

Opens a dialog box to adjust the display refresh rate. The time in milliseconds between two refresh operations is entered. The default setting is 200 ms.



Colours

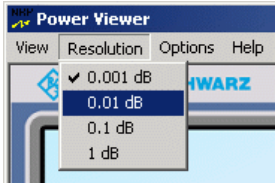
Result
Unit
Edit
Button

Opens a dialog box to select the background colour for

- the result,
- the unit,
- the text in the number fields or
- the key labelling.

Resolution

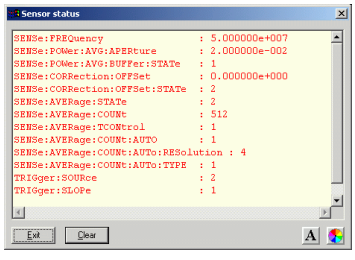
For setting the result resolution. If auto-averaging has been selected, a higher resolution leads to a greater averaging factor, which means a longer result settling time.



Options

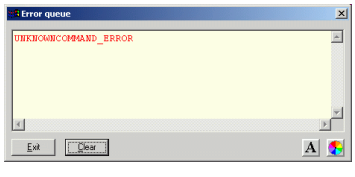
Read Sensor Status …

Reads the current status of the power sensor. A parameter list is output.



Read Error Queue …

Reads the error queue. All the error messages that have been issued since the last call are read line-by-line. A tick before this menu entry indicates that an error has occurred.



	Simulation …	Allows you to try out the functions of the virtual power meter even without a power sensor. The display alternates between **Measurement Value 1** & **Measurement Value 2** with a period given by **Interval**. Simulation can be activated immediately with the **Activate** check box.
	Reset Sensor	Initializes the power sensor. Any previous zeroing remains valid.
Help	**Contents**	Opens the table of contents for the online-help facility.
	About	Displays information about the program version used, etc.

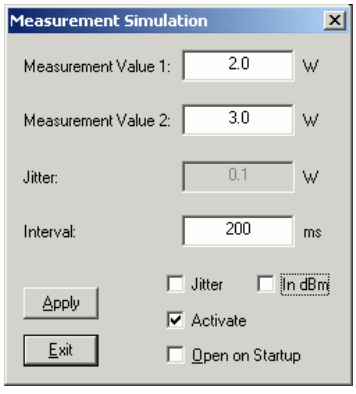


Table of Contents

3 Manual Operation 3.1

Program module "Terminal" 3.1
Main control elements 3.1
Menus 3.3
Program module "Firmware Update" 3.6
Program module "Update S-Parameters" 3.6
Fundamentals 3.6
Procedure 3.8

Figs.

Fig. 3-1 Sending commands using the **Input** field 3.1
Fig. 3-2 Sending commands using command files 3.2
Fig. 3-3 Dialog window for loading an s-parameter table....3.9
Fig. 3-4 Dialog window for loading the backup file of a calibration data set 3.10
Fig. 3-5 Subsequently changing the default behaviour of the s-parameter correction 3.10

Tables

Table 3-1 Buttons assigned to the **Input** field 3.2
Table 3-2 Buttons assigned to the **Command File** field 3.2
Table 3-3 Buttons assigned to the **Output** field 3.3
Table 3-4 Uncertainties of the s-parameter test system (example) 3.7
Table 3-5 Interpolated uncertainties of measurement frequencies for s-parameters (example) 3.7

3 Manual Operation

The previous section describes the **Power Viewer** program module supplied with the instrument. This module simplifies the most frequently used function of a power meter – measuring the average power of an RF signal of almost any modulation. Other program modules are also part of the supplied equipment and can be selected in the Start menu:

- **Power Viewer**: A detailed description of this virtual power meter module is provided in section 2.
- **Terminal**: Program module for sending commands and command sequences to the sensor and for displaying measurement results, status information and other data from the sensor
- **Firmware Update**: Program module for updating the sensor firmware
- **Update S-Parameters**: Program module for loading an s-parameter table into the sensor

Program module "Terminal"

Main control elements

With the USB terminal, commands and command sequences can be sent to the sensor in two different ways:

- Commands are entered in the **Input** field (Fig. 3-1). Consecutive commands can be entered as separate lines, one below the other. The buttons associated with the **Input** field are described in Table 3-1.
- Commands or command sequences are stored in *command files*. Command files are created with a text editor, for instance, and then stored. They can be called as often as required (Fig. 3-2). The buttons of the **Command File** field are described in Table 3-2.

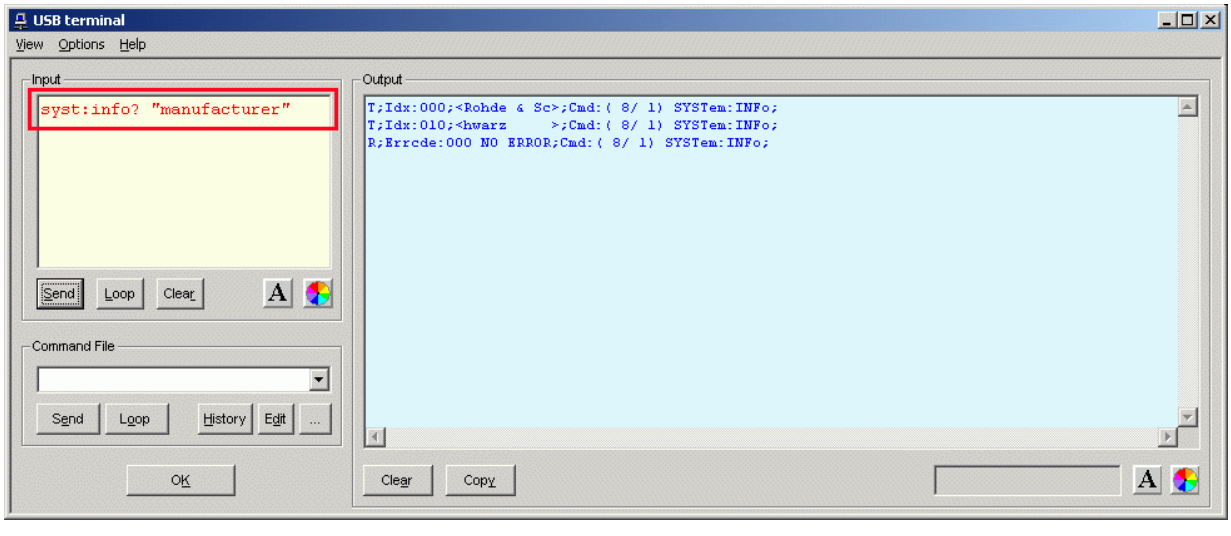


Fig. 3-1 Sending commands using the **Input** field

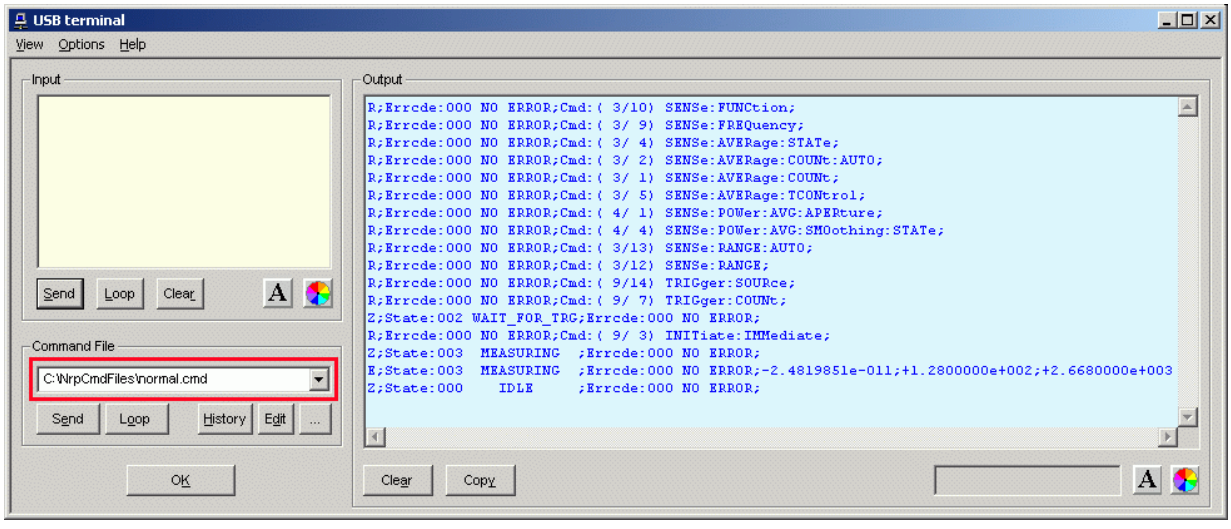


Fig. 3-2 Sending commands using command files

Table 3-1 Buttons assigned to the **Input** field

Button	**Function**	**Key combination**
Send	Sends the content of the **Input** entry field to the sensor.	Alt + S
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + L
Clear	Clears the content of the **Input** field.	Alt + R
Font key	Opens a dialog window where the font for the **Input** field can be selected.	
Colour key	Opens a dialog window where the background colour of the **Input** field can be selected.	

Table 3-2 Buttons assigned to the **Command File** field

Button	**Function**	**Key combination**
Send	Sends the content of the command file to the sensor.	Alt + E
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + O
History	Opens a window for editing the command file name in the **Command File** field.	Alt + H
Edit	Opens the selected command file in the Windows™ text editor.	Alt + D
…	Opens a file opening dialog for selecting the command file.	

A command line starting with a tab, a blank or a special character is considered a comment and not forwarded to the sensor.

Measurement results, parameters and status information returned by the sensor are displayed in the **Output** field.

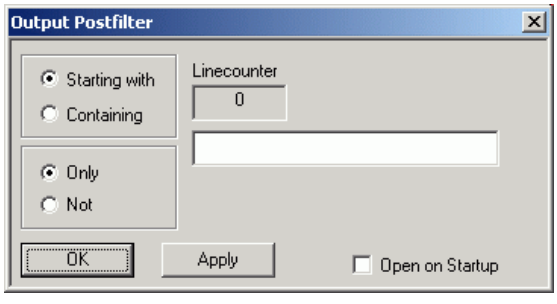
Table 3-3 Buttons assigned to the **Output** field

Button	**Function**	**Key combination**
Clear	Clears the content of the **Output** field	Alt + A
Copy	Copies the content of the **Output** field to the clipboard. (Another possiblity: mark the desired information in the output window with the mouse cursor, press the right mouse key or Ctrl+C and then copy the selected text to the clipboard using the menu item **Copy** in the opened context menu.)	Alt + Y
Font button	Opens a dialog window where the font for the **Output** field can be selected.	
Colour button	Opens a dialog window where the background colour of the **Output** field can be selected.	

Close the USB terminal with OK.

Menus

View **Post Filter …** Opens the **Output Postfilter** dialog window where the lines stored in the input buffer can be filtered according to different criteria.



Filter criteria:

Only + **Starting with**: Only lines starting with the entered character string are displayed.

Not + **Starting with**: Only lines not starting with the entered character string are displayed.

Only + **Containing**: Only lines containing the entered character string are displayed.

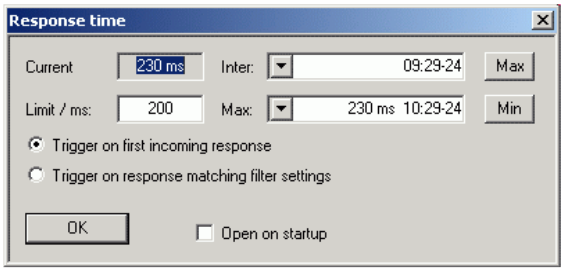
Not + **Containing**: Only lines not containing the entered character string are displayed.

Lines not matching the specific filter criterion are blanked but not cleared.

Filtering is started with **Apply**. The number of lines matching the filter criterion is displayed in the **Linecounter** field. If **Open on startup** is active, the **Output Postfilter** dialog is automatically opened when the terminal is started. The dialog window is closed with **OK**.

Response Time …

Opens the **Response time** dialog window where the response time of the power sensor can be set.



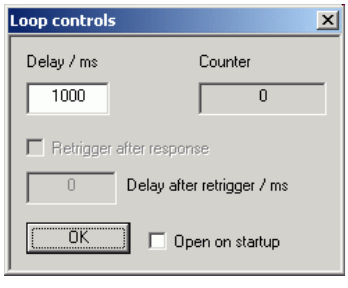
Current indicates the time elapsed between dispatch of the last command and receipt of an acknowledgement from the power sensor. When the **Max** button is clicked, the response times exceeding the value in the **limit / ms** field are recorded. When the **Min** button is clicked, the response times within the value in the **limit / ms** field are recorded.

If **Trigger on first incoming response** is active, the time measurement is terminated as soon as the first response arrives after a command is sent. If **Trigger on response matching filter settings** is active, the time measurement is terminated as soon as the first response matching the filter criterion in the **Output Postfilter** dialog window is received.

If **Open on startup** is active, the **Response Time** dialog is automatically displayed when the Terminal module is started. The dialog window is closed with **OK**.

Loop …

Opens the **Loop controls** dialog window where the cyclic transfer of commands and command sequences can be controlled.



In the **Delay / ms** field, the time interval for the cyclic transfer is specified in milliseconds.

The number of completed transfer cycles is displayed in the **Counter** field. If **Open on startup** is active, the **Response time** dialog is automatically opened when the Terminal module is started. The dialog window is closed with **OK**.

Options

Protocol Mode In this mode, a time stamp is added to each response block.

Hex Mode In this mode, the response blocks from the power sensor are displayed in hexadecimal format.

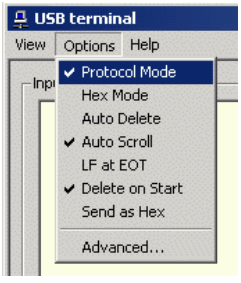
Auto Delete With this option active, the **Output** field is automatically cleared when the **Send** button is pressed.

Auto Scroll With this option active, older items in the **Output** field are automatically shifted upward and off the display if space is required for new values.

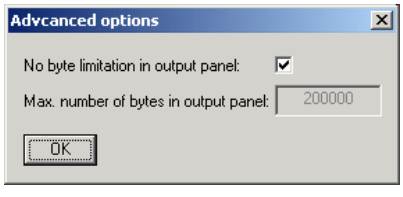
LF at EOT With this option active, a line feed is appended to each response block from the power sensor.

Delete on Start With this option active, the **Output** field is automatically cleared when the **Terminal** module is started.

Send as Hex With this option active, the text in the **Input** field is interpreted as a hexadecimal character sequence.



Advanced … Opens a dialog window where the buffer size for the **Output** field can be set.



Help

Contents Opens the table of contents for the online help.

About Displays information about the program version, etc.

Program module "Firmware Update"

A detailed description of the program module for firmware updates is provided in the Service Manual.

Program module "Update S-Parameters"

Fundamentals

This program module allows you to modify an s-parameter data set located in the data memory of R&S NRP sensors. This s-parameter data set is required in order to automatically account for the influence of a twoport connected ahead of the sensor. In the case of the R&S NRP-Z92 sensor, the data set contains the s-parameters of the attenuator supplied in the delivery. The program module **Update S-Parameters** can be used to update these values after the attenuator is calibrated or to save another data set – for a separate attenuator or twoport – to the data memory.

The R&S NRP-Z92 sensor and the attenuator supplied in the delivery are measured separately during calibration. If the attenuator is used, its effect on the result value of the sensor is corrected arithmetically. The set of calibration data in the R&S NRP-Z92 therefore includes an s-parameter table with up to 1000 measurement frequencies. The real and the imaginary part of each frequency as well as the uncertainty of s-parameters s_{11}, s_{12}, s_{21} and s_{22} can be stored. Since the measurement frequencies in the s-parameter table are independent of the calibration frequencies, they can be set so that the twoport frequency range of interest is optimally covered. The real and the imaginary parts between these measurement frequencies are linearly interpolated, while the more substantial measurement uncertainty at the two neighbouring frequency points is used for calculating the uncertainty of the measurement result. Below the first and above the last measurement frequency, the values of the first and the last measurement frequency are used, respectively.

For maximum measurement sensitivity, the sensor R&S NRP-Z92 can be operated without a connected attenuator. In this case, the s-parameter correction must be deactivated.

Moreover, with the sensor R&S NRP-Z92 the influence of any twoport connected to the input on the measurement result can be corrected by way of calculation. A precondition is that a complete set of s-parameters of the twoport is available in the frequency range in question. The calibration data set comes factory-set with the s-parameters of the supplied attenuator; the s-parameter correction is activated as standard.

To ensure compatibility with a great number of network analyzers, the program module **Update S-Parameters** can process measurement data files in S2P format. All standard frequency units (Hz, kHz, MHz, GHz) and display formats (real and imaginary part, linear magnitude and phase, magnitude in dB and phase) are supported. The only restriction is that a reference impedance of 50 Ω must be used for the s-parameters. Additional noise parameters in the measurement data file are ignored.

Structure of the S2P measurement data file:

1. The *option line* has the following format (square brackets indicate that the enclosed content is optional):

    # [<frequency unit>] [<parameter>] [<format>] [<R n>]

    # identifies the *option line*.

    The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.

    If a parameter is specified, S must be used in <parameter> for s-parameter files. If a parameter is not specified, S is implicitly assumed.

    The <format> may be MA (linear magnitude and phase in degree), DB (magnitude in dB, phase in degree) or RI (real and imaginary part). If a format is not specified, MA is implicitly assumed.

    R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.

The *option line* should therefore read:
[HZ | KHZ | MHZ | GHZ] [S] [MA | DB | RI] [R 50]

2. The measurement frequencies in ascending order are specified as follows:
$f_i \;\; s_{11}(f_i) \;\; s_{21}(f_i) \;\; s_{12}(f_i) \;\; s_{22}(f_i)$,
where $s_{jk}(f_i)$ is the display format as specified in the *option line*:

$|s_{jk}(f_i)| \;\; \arg s_{jk}(f_i)$ (display format for linear magnitude and phase in degree) or

$20 \cdot \lg |s_{jk}(f_i)| \;\; \arg s_{jk}(f_i)$ (display format for magnitude in dB and phase in degree)

$\mathrm{Re}\lfloor s_{jk}(f_i) \rfloor \;\; \mathrm{Im}\lfloor s_{jk}(f_i) \rfloor$ (display format for real and imaginary part)

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

To characterize the measurement uncertainty of the s-parameter test system, another data file can optionally be created. The syntax of the uncertainty data file is similar to that of the S2P data file but U is specified as <Parameter> in the *option line* so that the *option line* reads # Hz U for frequencies in Hz. The measurement frequencies must not be identical to those of the S2P measurement data files. In most cases a few entries will be sufficient to characterize the measurement uncertainty of the s-parameter test system. An s-parameter uncertainty as high as that of the neighbouring measurement frequencies of the uncertainty data file is then selected. If different values are available, the higher one is chosen. This is illustrated in the example below:

Table 3-4 Uncertainties of the s-parameter test system (example)

***f* in GHz**	**unc [$s_{ik}(f)$]**
0.1	0.01
1.0	0.01
1.1	0.005
10.0	0.005
10.1	0.01
40.0	0.01

Table 3-5 Interpolated uncertainties of measurement frequencies for s-parameters (example)

***f* in GHz**	**unc [$s_{ik}(f)$]**
0.9	0.01
0.95	0.01
1.0	0.01
1.05	0.01
1.1	0.005
1.15	0.005
1.2	0.005

At 1.05 GHz, the higher uncertainty of the two adjacent 1.0 GHz and 1.1 GHz measurement frequencies is entered in the s-parameter table. If an uncertainty of 0.005 is desired for all frequencies above 1.0 GHz, the first measurement frequency in the uncertainty data file must above 1.0 GHz, e.g. 1.000001 GHz.

Structure of the uncertainty data file (square brackets indicate that the enclosed content is optional):

1. The *option line* has the following format:
   # [<frequency unit>] <parameter> [<format>] [<R n>]
   # identifies the *option line*.
   The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
   U must be specified for <parameter> in uncertainty data files. If a parameter is not specified, S is implicitly assumed and as a result an error message is triggered.
   <format> is ignored in uncertainty measurement files; the entry is therefore irrelevant.
   R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] U [MA | DB | RI] [R 50]

2. Measurement frequencies in ascending order are specified in the following form:
   $f_i \quad \mathrm{unc}\left[s_{11}(f_i)\right] \quad \mathrm{unc}\left[s_{21}(f_i)\right] \quad \mathrm{unc}\left[s_{12}(f_i)\right] \quad \mathrm{unc}\left[s_{22}(f_i)\right].$
   The s-parameters uncertainties are forwarded as follows:
   - as extended absolute uncertainties ($k = 2$) for the magnitude of reflection parameters s_{11} and s_{22}, for instance 0.015,
   - as extended uncertainties ($k = 2$) in dB for the magnitude of transmission parameters s_{21} and s_{12}, for instance 0.015.

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

Two additional values must be specified when the s-parameters are loaded: the lower and the upper nominal measurement limit of the sensor-twoport combination. If s-parameter correction is active, these values are transferred by the sensor in response to *SYSTem:INFO?* The values cannot always be derived from the lower or upper measurement limit of the sensor alone and from the loss or gain of the preconnected twoport. The upper measurement limit of the sensor-twoport combination may also be limited by the twoport's maximum power-handling capacity. Furthermore, the lower measurement limit may be raised not only by the loss but also by the inherent noise of the twoport. For this reason, these values must be entered manually.

NOTICE *The upper nominal measurement limit of the sensor-twoport combination entered when loading the s-parameters should be carefully specified, as automatic test systems may evaluate it and an incorrect value may cause the sensor and/or the twoport to be overloaded.*

Procedure

To load an s-parameter table into the calibration set of the sensor, proceed as follows:

1. Connect the sensor to the USB port of the PC and start the program module **Update S-Parameters**. The corresponding dialog window is opened (Fig. 3-3).
2. Make sure **Keep Current S-Parameter Data** is deactivated.
3. Under **S-Parameter File** enter the search path and the name of the S2P file containing the parameters. Press the **Browse**... button to open a file-opening dialog where the S2P measurement data file can be easily selected.
4. Under **Uncertainty File** enter the search path and the name of the measurement uncertainty file containing the measurement uncertainty of the s-parameter test system. Press the **Browse**... button to open a file-opening dialog where the measurement uncertainty file can be easily selected.

5. Enter the upper and lower nominal measurement limit of the sensor-twoport combination in the **Lower Power Limit** and **Upper Power Limit** fields**.**
6. Enter a name for the loaded s-parameter set in the **S-Parameter Device Mnemonic** field. This name can later be queried with *SYSTem:INFO? "SPD Mnemonic"* and is displayed on the NRP basic unit when s-parameter correction is switched on.
7. Activate **S-Parameter Correction on by Default** if the *SENSe:CORRection:SPDevice:STATe* switch should be automatically set to *ON* when the sensor is put into operation.
8. Designations for calibration laboratory and person responsible for calibration may be entered in the **Calibration Lab** and **Calibration Engineer** fields. These designations are stored in the calibration data set. They are implicitly set to „user lab“ and „user“, respectively, if the fields are left blank.
9. Press **Start** for loading. (The dialog is closed with **OK** and the set parameters are retained. When the dialog is exited with **Cancel**, all parameter modifications are ignored.)

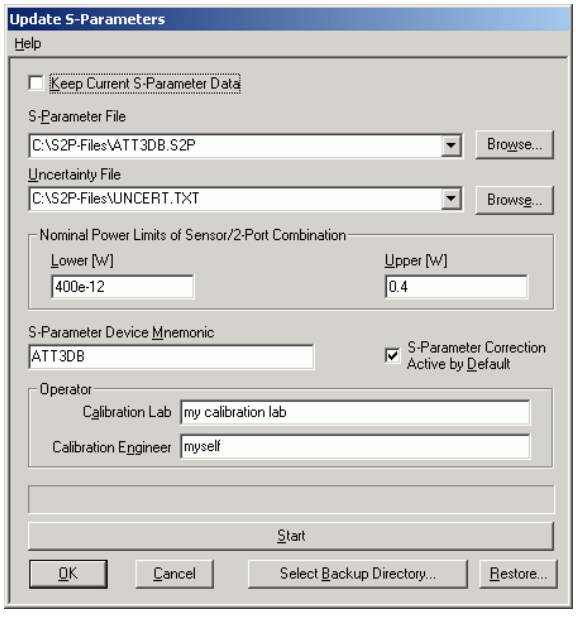


Fig. 3-3 Dialog window for loading an s-parameter table

During loading, the current calibration data set of the sensor is overwritten. To be on the safe side, a backup copy of the current calibration data set is therefore automatically stored before s-parameters are loaded. The names of the backup files have the structure <type>_<batch number>_<date>_<time>.bak, where <type> is the sensor type, <batch number> is the batch number of the sensor, <date> the date of the s-parameter update in yyyymmdd format and <time> the time of the s-parameter update in the format hhmmss. By default, a subdirectory named “Backup” is created for the backup files in the program directory. With **Select Backup Directory …** it is possible to select a different directory.

Store the automatically created backup files on a separate data medium (e.g. diskette, CD-ROM or network drive) and, if required, assign a meaningful name to them to simplify reloading. With the aid of these files, a previously used calibration data set of the sensor can be restored.

To reload the backup file of a calibration data set into the sensor, proceed as follows:

1. Press the **Restore...** button. The **Restore S-Parameters** window is opened (Fig. 3-4).
2. Enter the search path and the name of the backup file in the **Backup File** field. Press the **Browse**... button to open a dialog where the backup file can be easily selected.
3. Press **OK** to start the restore procedure. (With **Cancel** the dialog window is exited without data being restored).

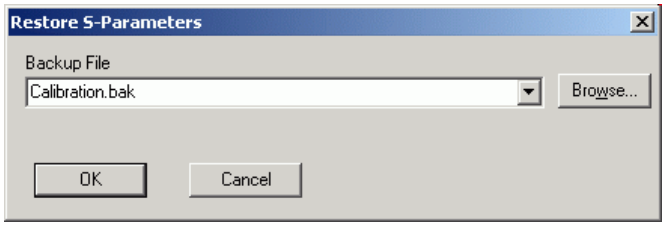


Fig. 3-4 Dialog window for loading the backup file of a calibration data set

To be able to determine if the s-parameter correction is active after plugging in or resetting the sensor, proceed as follows:

1. Connect the sensor to the USB port of the PC and start the program module **Update S-Parameters**.
2. Make sure **Keep Current S-Parameter Data** is activated (Fig. 3-5).
3. Activate **S-Parameter Correction on by Default** if the *SENSe:CORRection:SPDevice:STATe* switch should be automatically set to *ON* when the sensor is put into operation, otherwise deactivate it.
4. Press **Start** for loading.

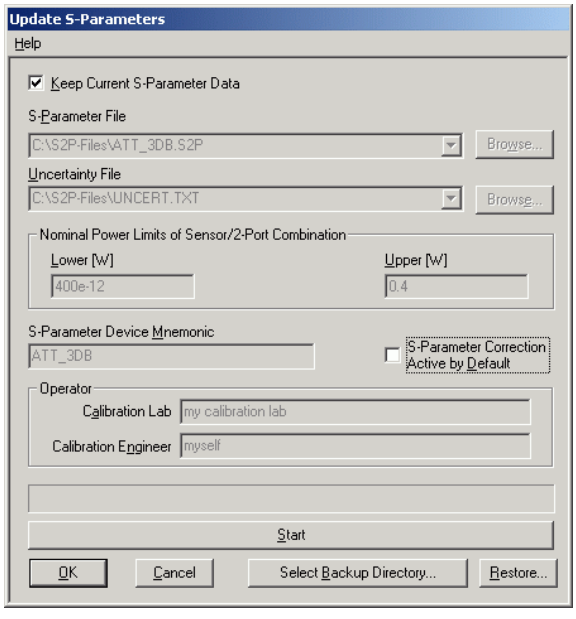


Fig. 3-5 Subsequently changing the default behaviour of the s-parameter correction

Contents

4 Removal and Installation of Attenuator 4.1

Removal of attenuator 4.1

Installation of attenuator 4.2

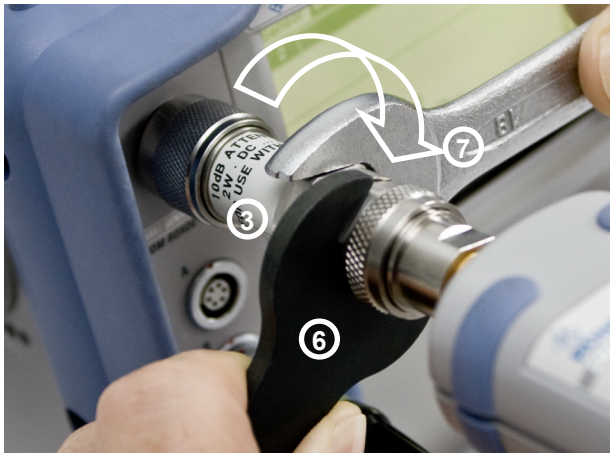
4 Removal and Installation of Attenuator

Removal of attenuator

Necessary tools:

- Open-end wrench (6) included with supplied accessories
- Open-end wrench (7) with width across flats 18 mm (not included in equipment supplied)
- Instrument with female N connector

To make removal easier, screw the sensor to the female N connector of an instrument (e.g. R&S NRP) using the union nut (2).



Undo the lock nut (3) securing the attenuator using the open-end wrench (7). To do so, counterhold the union nut (4) of the sensor using the open-end wrench (6).

Turn back the lock nut (3) by one or two turns.

Undo the union nut (4) by hand; use the open-end wrench (6) if necessary.

Detach the power sensor from the female N connector of the attenuator.

Installation of attenuator

Installation is performed in the reverse order of removal. Screw the union nut (4) to the attenuator (2) finger-tight only. Always use both open-end wrenches to tighten the lock nut (3).

Table of Contents

5 Remote Control – Fundamentals 5.1

5 Remote Control – Fundamentals

Rohde & Schwarz recommends to utilize the VXI Plug & Play Driver for the remote control of R&S NRP power sensors. This driver can be found on the CD-ROM supplied with the sensor or downloaded in its most recent version via the internet (http://rohde-schwarz.com/).

The old remote control interface provided by the *Dynamic Link Library NrpControl.dll* is not developed further, but remains on the CD-ROM and can be downloaded via the internet.

Table of Contents

6 Remote Control – Commands 6.1

Notation 6.1

Commands as per IEEE 488.2 ..... 6.2

*IDN? – Identification Query 6.2

*RST – Reset 6.2

*TRG – Trigger 6.2

*TST? – Self Test Query 6.2

SCPI Commands 6.3

CALibration 6.3

CALibration:DATA[?] <calibration data set as *definite length block*> 6.3

CALibration:DATA:LENGth? 6.3

CALibration:ZERO:AUTO[?] OFF | ON | ONCE 6.4

SENSe (Sensor Configuration) 6.5

SENSe:AVERage:COUNt[?] 1 to 65536 ..... 6.6

SENSe:AVERage:COUNt:AUTO[?] OFF | ON | ONCE 6.6

SENSe:AVERage:COUNt:AUTO:MTIMe[?] 0.01 to 999.99 ..... 6.7

SENSe:AVERage:COUNt:AUTO:NSRatio[?] 0.0 to 1.0 ..... 6.7

SENSe:AVERage:COUNt:AUTO:RESolution[?] 1 to 4 ..... 6.7

SENSe:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSRatio 6.7

SENSe:AVERage:RESet 6.7

SENSe:AVERage:STATe[?] OFF | ON 6.8

SENSe:AVERage:TCONtrol[?] MOVing | REPeat 6.8

SENSe:CORRection:DCYCle[?] 0.001 to 99.999 ..... 6.8

SENSe:CORRection:DCYCle:STATe[?] OFF | ON 6.8

SENSe:CORRection:OFFSet[?] –200.0 to 200.0 ..... 6.9

SENSe:CORRection:OFFSet:STATe[?] OFF | ON 6.9

SENSe:CORRection:SPDevice:STATe[?] OFF | ON 6.9

SENSe:FREQuency[?] 9.0e3 to 6.0e9 ..... 6.9

SENSe:FUNCtion[?] <sensor_function> 6.10

SENSe:POWer:AVG:APERture[?] 10.0e–6 to 0.3 ..... 6.10

SENSe:POWer:AVG:BUFFer:SIZE[?] 1 to 1024 ..... 6.10

SENSe:POWer:AVG:BUFFer:STATe[?] OFF | ON 6.11

SENSe:POWer:AVG:SMOothing:STATe[?] OFF | ON 6.11

SENSe:SGAMma:CORRection:STATe[?] OFF | ON 6.11

SENSe:SGAMma:MAGNitude[?] 0.0 to 1.0 ..... 6.12

SENSe:SGAMma:PHASe[?] –360.0 to 360.0 ..... 6.12

SYSTem....6.13
SYSTem:INFO? [Item]....6.13
SYSTem:INITialize....6.15
SYSTem:MINPower?....6.15
SYSTem:RUTime[?] 0.0 to 10.0....6.15
SYSTem:SUTime[?] 0.0 to 10.0....6.15
SYSTem:TRANsaction:BEGin....6.15
SYSTem:TRANsaction:END....6.16
TEST....6.17
TEST:SENSor?....6.17
TRIGger....6.18
ABORt....6.18
INITiate:CONTinuous[?] OFF | ON....6.18
INITiate:IMMediate....6.19
TRIGger:COUNt[?] 1 to 2^{31}....6.19
TRIGger:DELay[?] 0 to 100.0....6.19
TRIGger:DELay:AUTO[?] OFF | ON....6.20
TRIGger:HOLDoff[?] 0.0 to 10.0....6.20
TRIGger:HYSTeresis[?] 0.0 to 10.0....6.20
TRIGger:IMMediate....6.20
TRIGger:LEVel[?] x to y....6.20
TRIGger:SLOPe[?] POSitive | NEGative....6.21
TRIGger:SOURce[?] HOLD | IMMediate | INTernal | BUS | EXTernal |....6.21
List of Remote-Control Commands....6.23

Figs.

Fig. 6-1 Correction of interactions between the power sensor, the signal source, and the s-parameter device 6.12

Fig. 6-2 Correction of interactions between the power sensor without attenuator and the signal source 6.12

Tables

Table 6-1 Commands of the *CALibration* system 6.3

Table 6-2 Commands of the *SENSe* system 6.5

Table 6-3 Measurement mode "POWer:AVG" 6.10

Table 6-4 Commands of the *SYSTem* system 6.13

Table 6-5 Meaning of *Item* in the *SYSTem:INFO?* command 6.13

Table 6-6 Commands of the *TEST* system 6.17

Table 6-7 Commands of the *TRIGger* system 6.18

Table 6-8 List of remote-control commands 6.23

6 Remote Control – Commands

Notation

In the following sections, all commands implemented in the sensor are first listed in a table according to command systems and are then described in detail. The notation is largely in line with the SCPI standard.

Command tables For a quick overview of available commands, the commands are listed in a table before they are described. These tables contain the following four columns:

Command: Commands and their tree structure.
Parameters: Possible parameters.
Unit: The basic unit of the physical parameters (must not be sent with parameters).
Remarks: Identification of all commands
- that have no query form
- that are available as query only

Indentations The various levels of the SCPI command hierarchy are shown in the table by indentations to the right. The lower the level, the greater the indentation to the right. It should be noted that the complete notation of the command includes the higher levels too.

Example:
SENSe:AVERage:COUNt is represented in the table as follows:

SENSe	first level
:AVERage	second level
:COUNt	third level

In the individual description, the command is shown in full length. An example of the command is given at the end of the description.

[?]
? A question mark in square brackets at the end of a command indicates that this command can either be used as a setting command (without question mark) or as a query (with question mark). If the question mark is not in square brackets, the command is a query only.

Example:
SENSe:POWer:AVG:APERture[?]
SENSe:POWer:AVG:APERture 1e-3 sets the length of the sampling window to 1 ms.
SENSe:POWer:AVG:APERture? Returns the currently set length as a response.

**IDN?* Queries the sensor identification string that of course cannot be changed. For this reason, this command is only available as a query.

Special characters | for parameters A vertical bar between parameters is used to separate alternative options (OR link).

Example:
INITiate:CONTinuous OFF | ON
The parameter *OFF* or *ON* can be entered.

{numeric expression} A numeric expression in braces means that it has been rounded to the nearest integral value.

<parameter>
<variable> A parameter or a variable in triangular brackets expresses its current value.

Commands as per IEEE 488.2

The sensor supports a subset of the possible setting commands and queries *(Common Commands and Queries)* in line with IEEE 488.2.

*IDN? – Identification Query

**IDN?* returns a string with information on the sensor's identity (device identification code). In addition, the version number of the installed firmware is indicated. The string for a sensor of type R&S NRP-Z51 has the following structure:

ROHDE&SCHWARZ,NRP-Z51,<serial number>,<firmware version>

<serial number>: Serial number in ASCII
<firmware version>: Firmware version number in ASCII

*RST – Reset

**RST* sets the sensor to the default state, i.e. the default settings for all test parameters are loaded.

*TRG – Trigger

**TRG* triggers a measurement. For this purpose, the sensor is in the *WAIT_FOR_TRIGGER* state and the source for the trigger event is set to *BUS* (*TRIGger:SOURce BUS*).

*TST? – Self Test Query

**TST?* starts a selftest and returns 0 (no error found) or 1 (an error has occurred). The selftest comprises the following functions:

- RAM test
- Operating voltages
- Temperature measurement
- Calibration data set
- Noise
- Zero-point offsets.

SCPI Commands

The sensor R&S NRP-Z92 is controlled via the groups of commands

- CALibration (zeroing)
- SENSe (measurement configurations)
- SYSTem
- TRIGger
- SERVice.

CALibration

Table 6-1 Commands of the *CALibration* system

Command	Parameter	Unit	Remarks
CALibration			
:DATA[?]	<calibration data set as definite length block>		
:LENGth?		Bytes	Query only
:ZERO			
:AUTO[?]	OFF | ON | ONCE		

CALibration:DATA[?] <calibration data set as *definite length block*>

CALibration:DATA is used for writing a calibration data set in the flash memory of the sensor.

The query yields the calibration data set currently stored in the flash memory as a *definite length block*.

CALibration:DATA:LENGth?

CALibration:DATA:LENGth? yields the length in bytes of the calibration data set currently stored in the flash memory. Programs that read out the calibration data set can use this information to determine the capacity of the buffer memory required.

CALibration:ZERO:AUTO[?] OFF | ON | ONCE

The commands *CALibration:ZERO:AUTO ON* and *CALibration:ZERO:AUTO ONCE* zeroes the three measurement paths of the sensor. For this purpose, the test signal must be deactivated or the sensor disconnected from the signal source. The sensor automatically detects the presence of any significant power to be measured. This causes zeroing to be aborted and error message *NRPERROR_CALZERO* to be output. The command *CALibration:ZERO:AUTO OFF* is ignored. Zeroing takes four seconds at a minimum, but at least as long as the selected averaging filter needs for settling (only fixed-filter mode).

Repeat zeroing

- *during warm-up after switching on or connecting the instrument*
- *after a substantial variation of the ambient temperature*
- *after fastening the sensor to an RF connector at high temperature*
- *after several hours of operation*
- *when very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.*

For zeroing switch off the test signal and do not remove the sensor from the signal source. Apart from keeping the thermal balance, this has the advantage that the noise superimposed on the test signal (e.g. from a broadband amplifier) can be detected on zeroing and does not impair the measurement result.

The query always yields *1* (= *OFF*).

Default setting
After a power-on reset, the zero offsets determined during the last calibration are used until the first zeroing. Therefore, very slight zero offsets are to be expected with a warmed up sensor. Initialization by means of **RST* or *SYSTem:INITialize* has no influence on the current zero offsets.

SENSe (Sensor Configuration)

The sensor is configured by means of the commands of the groups *SENSe* and *TRIGger*.

Table 6-2 Commands of the *SENSe* system

Command	Parameter	Unit	Remarks
SENSe			
:AVERage			
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF | ON | ONCE		
:TYPE[?]	RESolution | NSRatio		
:MTIMe[?]	0.01 to 999.99	s	
:NSRatio[?]	0.0 to 1.0	dB	
:RESolution[?]	1 to 4		
:RESet			No query
:STATe[?]	OFF | ON		
:TCONtrol[?]	MOVing | REPeat		
:CORRection			
:DCYCle[?]	0.001 to 99.999	%	
:STATe[?]	OFF | ON		
:OFFSet[?]	–200.0 to 200.0	dB	
:STATe[?]	OFF | ON		
:SPDevice:STATe[?]	OFF | ON		
:FREQuency[?]	9.0e3 to 6.0e9	Hz	
:FUNCtion[?]	“POWer:AVG“		
:POWer			
:AVG			
:APERture[?]	10.0e-6 to 0.3	s	
:BUFFer			
:SIZE[?]	1 to 1024		
:STATe[?]	OFF | ON		

Command	Parameter	Unit	Remarks
:SMOothing:STATe[?]	OFF | ON		
:SGAMma			
:CORRection:STATe[?]	OFF | ON		
:MAGNitude[?]	0.0 to 1.0		
:PHASe[?]	–360.0 to 360.0	degree	

SENSe:AVERage:COUNt[?] 1 to 65536

SENSe:AVERage:COUNt sets the number of measured values that have to be averaged for forming the measurement result. The higher this averaging factor, the less the measured values fluctuate and the longer the measurement time lasts. The parameter is rounded off to the nearest power-of-two number.

The query yields the set averaging factor.

The averaging function must be activated with SENSe:AVERage:STATe ON *so that the set averaging factor becomes effective.*

Default setting: *4*

SENSe:AVERage:COUNt:AUTO[?] OFF | ON | ONCE

SENSe:AVERage:COUNt:AUTO activates (auto-averaging) or deactivates (fixed-filter mode) automatic determination of the averaging factor. If auto-averaging is activated, the averaging factor is continuously determined and set depending on the level of power and other parameters.

SENSe:AVERage:COUNt:AUTO ON activates auto-averaging and *SENSe:AVERage:COUNt:AUTO OFF* deactivates it. On deactivation, the previous, automatically determined averaging factor is used in the fixed-filter mode. The *SENSe:AVERage:COUNt:AUTO ONCE* command ensures that a new averaging factor is determined by the filter automatic function under the current measurement conditions and used in the fixed-filter mode.

The query yields
- *1* for *OFF,*
- *2* for *ON*.

Default setting: *ON*

SENSe:AVERage:COUNt:AUTO:MTIMe[?] 0.01 to 999.99

SENSe:AVERage:COUNt:AUTO:MTIMe sets an upper limit for the settling time of the auto-averaging filter in the *NSRatio* mode and thus limits the length of the filter.

The query returns the time that has been set.

Default setting: *4.0 [s]*

SENSe:AVERage:COUNt:AUTO:NSRatio[?] 0.0 to 1.0

SENSe:AVERage:COUNt:AUTO:NSRatio determines the relative noise component in the measurement result if auto-averaging is operated in the corresponding mode (*SENSe:AVERage:COUNt:AUTO:TYPE NSRatio*). The noise component is defined as the magnitude of the level variation in dB caused by the inherent noise of the sensor (two standard deviations).

The query yields the relative noise component in the result.

Default setting: *0.01 [dB]*

SENSe:AVERage:COUNt:AUTO:RESolution[?] 1 to 4

SENSe:AVERage:COUNt:AUTO:RESolution sets the resolution index for the automatic averaging filter. The resolution index equals the number of decimal places that have to be taken into account for the further processing of the measurement result in dBm, dBµV or dB. The normal mode is designed in a similar manner as for the predecessors R&S NRVS and R&S NRVD or other commercial power meters. The higher the selected index, the better the measurement result is filtered without the last significant place (0.01 dB with an index of 3) actually being set. The NSRatio setting is recommended instead.

The query yields the resolution index.

Default setting: *3*

SENSe:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSRatio

SENSe:AVERage:COUNt:AUTO:TYPE defines the automatic averaging filter mode. The *RESolution* parameter sets the mode usual for power meters; *NSRatio* predefines the compliance to an exactly defined noise component.

The query yields

- *1* for *RESolution*,
- *2* for *NSRatio*.

Default setting: *RESolution*

SENSe:AVERage:RESet

SENSe:AVERage:RESet initializes the averaging filter. This is useful if a high averaging factor is set in the *SENSe:AVERage :TCONtrol MOVing* filter mode and if the power to be measured has significantly decreased since the previous measurement, e.g. by several powers of ten. In this case, previous measurement results still contained in the averaging filter strongly affect the settling of the display; as a result, the advantage of the *SENSe:AVERage:TCONtrol MOVing* filter mode, i.e. the ability to detect trends in the measurement result while the measurement is still in progress, is lost. The *SENSe:AVERage:RESet* command solves this problem by deleting all previous measurement results that the averaging filter contains. After initialization, the filter length gradually increases from 1 to its nominal value *SENSe:AVERage:COUNt*, so that trends in the measurement result become quickly

apparent. However, this procedure does not shorten the measurement time required in order for the averaging filter to settle completely.

SENSe:AVERage:STATe[?] OFF | ON

SENSe:AVERage:STATe switches on or off the averaging filter.

The query yields
- *1* for *OFF,*
- *2* for *ON*.

Default setting: *ON*

SENSe:AVERage:TCONtrol[?] MOVing | REPeat

SENSe:AVERage:TCONtrol (terminal control) defines the behaviour of the averaging filter. As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output, which is obtained from the new measured value and the other values stored in the filter.

The *MOVing* parameter defines that each new average value is output as a measurement result. This allows tendencies in the result to be recognized during the measurement procedure.

The *REPeat* parameter defines that a new result is output after the FIR filter has been filled with new measured values. This ensures that no redundant information is output.

The query yields
- *1* for *MOVing*,
- *2* for *REPeat*.

Default setting: *REPeat*

SENSe:CORRection:DCYCle[?] 0.001 to 99.999

SENSe:CORRection:DCYCle sets the duty cycle to a percent value for the correction of pulse-modulated signals. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power. Since the duty cycle is only useful in the *Continuous Average* mode, it is evaluated only there.

The query yields the current duty cycle in percent.

Default setting: *1.0 [%]*

SENSe:CORRection:DCYCle:STATe[?] OFF | ON

SENSe:CORRection:DCYCle:STATe ON activates the duty cycle correction and thus the pulse-power measurement whereas *SENSe:CORRection:DCYCle:STATe OFF* deactivates it.

The query yields
- *1* for *OFF,*
- *2* for *ON*.

Default setting: *OFF*

SENSe:CORRection:OFFSet[?] –200.0 to 200.0

SENSe:CORRection:OFFSet defines a fixed offset in dB, which is used to correct the measured value. (When a log scale is used, the offset is added to the measured value; this is the reason why the command has this name.)

The attenuation of an attenuator located ahead of the sensor or the coupling attenuation of a directional coupler is taken into account with a positive offset, i.e. the sensor calculates the power at the input of the attenuator or directional coupler. A negative offset can be used to correct the influence of a gain connected ahead.

The query yields the set offset in dB.

Default setting: *0.0 [dB]*

SENSe:CORRection:OFFSet:STATe[?] OFF | ON

SENSe:CORRection:OFFSet:STATe ON activates the offset correction and *SENSe:CORRection :OFFSet:STATe OFF* deactivates it.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:CORRection:SPDevice:STATe[?] OFF | ON

SENSe:CORRection:SPDevice:STATe ON activates the s-parameter data set for a component (attenuator, directional coupler) connected ahead of the sensor. Parameter *OFF* deactivates it.

The use of s-parameters instead of a fixed offset (see group of commands *SENSe:CORRection :OFFSet*) allows more precise measurements, since the interactions between the sensor, the source and components connected between them can be taken into account. (For detailed information on loading s-parameter data sets, refer to section 3.) The attenuator supplied with the sensor comes with a factory-set s-parameter data set. If the sensor is operated without a connected component, this parameter must be set to *OFF*.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting:
The factory-set default setting of the sensor is *OFF*. On loading a different s-parameter table, the default setting can be redefined (see section 3).

SENSe:FREQuency[?] 9.0e3 to 6.0e9

SENSe:FREQuency transfers the carrier frequency of the RF signal to be measured; this frequency is used for the frequency-response correction of the measurement result. The center frequency is set for broadband signals (*spread-spectrum* signals, multicarrier signals).

The query yields the set carrier frequency in Hz.

Default setting: *50.0e6 [Hz]*

SENSe:FUNCtion[?] <sensor_function>

In contrast to other sensors, the R&S NRP-Z92 only implements the *Continuous Average* mode. Therefore, the command *SENSe:FUNCtion <sensor_function>* only accepts the parameter *"POWer:AVG"*.

Table 6-3 Measurement mode "POWer:AVG"

<sensor_function>	Description of the measurement mode
"POWer:AVG"	**Continuous Average** In this mode, the average power of the measurement signal is asynchronously measured within definable time intervals (sampling windows). The width of a sampling window is set with the *SENSe:POWer:AVG:APERture* command. The measurements are performed with chopper stabilization to obtain more accurate measurement results with reduced noise and zero offset. Therefore, a single measurement is always performed over two sampling windows, the polarity of the detector output signal being reversed for the second window. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized. When the averaging function is activated, the averaging factor determines how often the described measurement cycle is repeated. A measurement should be started with the command *INITiate:IMMediate* (once) or *INITiate:CONTinuous ON* (continuously), the trigger source being set to *IMMediate* with the *TRIGger:SOURce* command (asynchronous measurement).

The query always yields *1* for *"POWer:AVG".*

Default setting: *"POWer:AVG"*

SENSe:POWer:AVG:APERture[?] 10.0e–6 to 0.3

SENSe:POWer:AVG:APERture defines the time interval (sampling window); measured values are continuously recorded in this interval. In manual operation, the default setting of 20 ms in conjunction with the activated smoothing is sufficient in most cases.

Larger sampling windows are needed when the measurement shows fluctuations due to modulation. It is then useful to adapt the size of the sampling window exactly to the modulation period, which yields an optimally stable display. If the modulation period varies or is not precisely known, the *Smoothing* function should also be activated (see command group *SENSe:POWer:AVG:SMOothing*). With smoothing activated, approx. 5 periods within a sampling window are sufficient to reduce the fluctuations caused by modulation to an acceptable degree; fluctuations are no longer perceptible with more than 9 periods. With smoothing deactivated, the situation is considerably more unfavorable. In this case, 300 instead of 5 periods are required, and the fluctuations do not disappear completely until there are 3000 or more periods.

The query yields the currently set width of the sampling window in seconds.

Default setting: *0.02 [s]*

SENSe:POWer:AVG:BUFFer:SIZE[?] 1 to 1024

SENSe:POWer:AVG:BUFFer:SIZE sets the buffer size for the buffered *Continuous Average* mode.

The query yields the current buffer size for the buffered *Continuous Average* mode.

Default setting: *1*

SENSe:POWer:AVG:BUFFer:STATe[?] OFF | ON

The buffered *Continuous Average* mode is activated with *ON* and deactivated with *OFF*. In this mode, the results generated by trigger events are collected in the sensor until the buffer is filled. All results are then transferred as block data. The measurement rate obtained is thus higher than in the non-buffered *Continuous Average* mode. The maximum measurement rate is obtained by combining the buffered mode with multiple triggering (see parameter *TRIGger:COUNt*). The size of the result buffer is set with the *SENSe:POWer:AVG:BUFFer:SIZE* command.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:POWer:AVG:SMOothing:STATe[?] OFF | ON

The *ON* parameter activates a smoothing filter for modulated signals in the *Continuous Average* mode and *OFF* deactivates it. The smoothing filter is a steep-edge digital lowpass filter used to suppress variations of results caused by low-frequency modulation. This parameter should be activated to reduce variations in results due to modulation when the size of the sampling window cannot or should not be exactly adapted to the modulation period. If the selected sampling window is 5 to 9 times larger than a modulation period, the variations in display are normally sufficiently reduced. With smoothing deactivated, 300 to 3000 periods are required to obtain the same effect.

With smoothing deactivated, the sampling values are considered equivalent and averaged in a sampling window, which yields an integrating behaviour of the measuring instrument. As described above, optimum suppression of variations in the result is thus obtained when the size of the sampling window is exactly adapted to the modulation period. Otherwise, the modulation can have a considerable influence, even if the sampling window is much larger than the modulation period. The behaviour can be considerably improved by subjecting sampling values to weighting (raised-von-Hann window), which corresponds to video filtering. This is exactly what happens with activated smoothing.

Since the smoothing filter increases the inherent noise of the sensor by approx. 20 %, it should remain deactivated if it is not required.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *ON*

SENSe:SGAMma:CORRection:STATe[?] OFF | ON

SENSe:SGAMma:CORRection:STATe ON initiates the use of the complex reflection coefficient Γ_{source} of the signal source defined with *SENSe:SGAMma:MAGNitude* and *SENSe:SGAMma:PHASe* for the correction of interactions between the power sensor and the signal source. This makes it possible to determine the power *P* delivered by the signal source with considerably greater accuracy. The complex reflection coefficient Γ_{sensor} of the sensor, which is also required for the correction, is prestored in the calibration data memory for a large number of frequencies.

If the gamma correction is made in connection with an s-parameter correction (leaving *SENSe:CORRection:SPDevice:STATe ON*), the interaction of the signal source with the s-parameter device on the one hand and the input of the power sensor on the other hand (depending on the magnitude of the term $| s_{12}\, s_{21} |$) is corrected. The interaction between the complex reflection coefficient Γ_{sensor} of the power sensor and the parameter s_{22} is always taken into account when the s-parameter correction is activated – independent of the gamma correction in connection with the signal source.

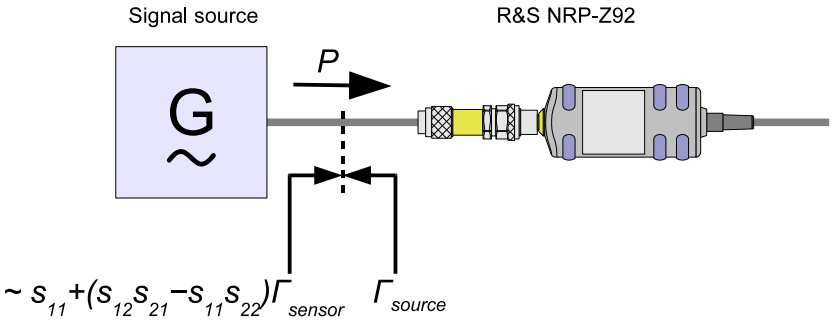


Fig. 6-1 Correction of interactions between the power sensor, the signal source, and the s-parameter device

The gamma correction is also functional if the R&S NRP-Z92 is operated without the attenuator supplied in the delivery or any other s-parameter device (setting *SENSe:CORRection :SPDevice:STATe ON*).

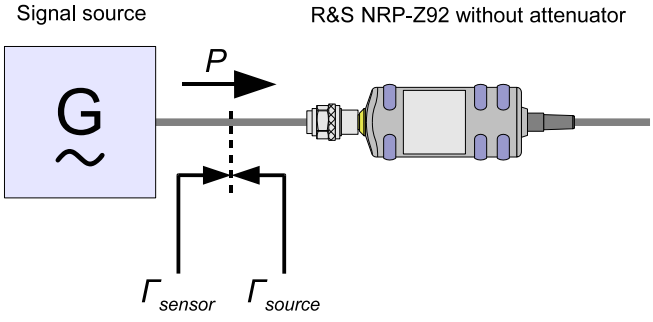


Fig. 6-2 Correction of interactions between the power sensor without attenuator and the signal source

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:SGAMma:MAGNitude[?] 0.0 to 1.0

SENSe:SGAMma:MAGNitude defines the magnitude of the complex reflection coefficient of the signal source. A value of *0.0* corresponds to ideal match and a value of 1.0 to total reflection.

The query yields the set magnitude.

Default setting: *0.0*

SENSe:SGAMma:PHASe[?] –360.0 to 360.0

SENSe:SGAMma:MAGNitude defines the phase angle (in degrees) of the complex reflection coefficient of the signal source.

The query yields the set phase angle.

Default setting: *0.0 [°]*

SYSTem

With the aid of the *SYSTem* system, administrative device settings can be defined and queried. This includes detailed information on the sensor and its initialization and the transfer of available commands and their parameter limits.

Table 6-4 Commands of the *SYSTem* system

Command	Parameter	Unit	Remarks
SYSTem			
:INFO? [Item]			Query only
:INITialize			No query
MINPower?		W	Query only
RUTime[?]	0.0 to 10.0	s	
SUTime[?]	0.0 to 10.0	s	
:TRANsaction			
:BEGIN:			No query
:END			No query

SYSTem:INFO? [Item]

SYSTem:INFO? yields a string containing information that is more detailed than the identification string delivered by the sensor as a response to **IDN?*. If no *Item* is specified, the response string is a sequence of entries in the form *Item:Information-String* separated by *CR* and *LF* (in C notation: *\r\n*). With the *Item* optionally appended to the command, the entry for the required *Item* can be queried. The response string is zero-terminated, i.e. its end identification is a zero byte (in C notation: *\0*).

Table 6-5 Meaning of *Item* in the *SYSTem:INFO?* command

Item	Information string	Remarks
"MANUFACTURER"	"Rohde & Schwarz GmbH & Co. KG"	Manufacturer
"TYPE"	"NRP-Z92"	Type designation
"STOCK NUMBER"	" 1171.7005.02"	Material number
"SERIAL"	"<serial number>"	6-digit serial number
"HWVERSION"	"000000000"	Hardware version (standard)
"HWVARIANT"	"000000000"	Hardware model (standard)
"SW BUILD"	"<build number>"	Version number of sensor firmware

Item	Information string	Remarks
"TECHNOLOGY"	"3 Path Diode"	Detector technology used
"FUNCTION"	"Power Terminating"	The R&S NRP-Z92 is a terminating power sensor.
"MINPOWER"	"<nominal lower test limit in W>"	If the supplied attenuator or another twoport is used and the s-parameter correction is activated, the information string depends on the nominal lower test limit of the sensor/twoport combination. Without a connected attenuator and with deactivated s-parameter correction, the nominal lower test limit is 200 pW, i.e. the sensor responds to SYSTem:INFo? "MINPOWER" with the information string "2e-10".
"MAXPOWER"	"<nominal upper test limit in W>"	If the supplied attenuator or another twoport is used and the s-parameter correction is activated, the information string depends on the nominal upper test limit of the sensor/twoport combination. Without a connected attenuator and with deactivated s-parameter correction, the nominal upper test limit is 200 mW, i.e. the sensor responds to SYSTem:INFo? "MAXPOWER" with the information string "0.2".
"MINFREQ"	"<min. measuring frequency in Hz>"	The minimum measuring frequency of the R&S NRP-Z92 is 9 kHz, i.e. the sensor returns the information string "9000" as a response to *SYSTem:INFo? "MINFREQ"*.
"MAXFREQ"	"<max. measuring frequency in Hz>"	The maximum measuring frequency is 6 GHz for the R&S NRP-Z92, i.e. the sensor returns the information string "6e+10" as a response to *SYSTem:INFo? "MAXFREQ"*.
"IMPEDANCE"	"50"	The R&S NRP-Z92 RF input has a nominal input impedance of 50 Ω.
"COUPLING"	"AC/DC"	The RF input of the R&S NRP-Z92 is DC-coupled, but DC voltages superimposed on the RF signal are suppressed by the measurement amplifier.
"CAL. ABS."	"<date>"	Date of absolute calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. REFL."	"<date>"	Date of reflection-coefficient calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. S PARA."	"<date>"	Date of s-parameter calibration in the format YYYY-MM-DD. If no S parameter set is loaded, the sensor returns the string "not applicable". "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. MISC."	"<date>"	Date of the calibration of other parameters in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"SPD MNEMONIC"	"<mnemonic string>"	Clear-text designation of the components connected ahead of the sensor.

SYSTem:INITialize

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

SYSTem:MINPower?

SYSTem:MINPower? yields the lower test limit of the sensor or the combination comprising the sensor and components connected ahead of it, if the *SENSe:CORRection:SPDevice* parameter has the *ON* value. This query can be used to determine a useful resolution for the result display near the lower test limit.

SYSTem:RUTime[?] 0.0 to 10.0

This command is used to limit the output rate of measurements with continuous output of measurement results (setting *INITiate:CONTinuous ON*). This is practical if the measurement time is very short or if intermediate values are output (command *SENSe:AVERage:TCONtrol MOVing* or *SENSe:TRACe:AVERage:TCONtrol MOVing*). Without this limitation, the controlling host can be overloaded very fast or excessively occupied with accepting measured values.

The parameter in the *SYSTem:RUTime* command is selected so that it equals the desired minimum interval between two measured value outputs. This is equivalent to the reciprocal of the output rate. If the measurement takes longer to begin with, the output rate decreases proportionately.

Default setting: *0.1 [s]*

SYSTem:SUTime[?] 0.0 to 10.0

This command is used to reduce the frequency of messages concerning status changes of the sensor from the *WAIT_FOR_TRIGGER* state to the *MEASURING* state.

Normally this status change is always sent to the control unit. If measurement times are very short and/or trigger events occur at a high frequency, however, this may lead to a heavy load on the remote-control connection which cannot be handled by the control unit (or host). The *SUTime* parameter can be used to define how long the sensor may remain in the *WAIT_FOR_TRIGGER* state without the corresponding status message being output.

SUTime is usually set to a value that is slightly smaller than the response time of the control system. Trigger events that have not yet occurred can then still be detected in time. At high trigger frequencies, the result is that after the start of the measurement, only the first changeover to the *WAIT_FOR_TRIGGER* state and the subsequent changeover to the *MEASURING* state are reported. The next message would not come until the transition to the IDLE state following the completion of the measurement.

Default setting: *0.0001 [s]*

SYSTem:TRANsaction:BEGin

SYSTEM:TRANsaction:BEGin marks the beginning of a sequence of setting commands between which the parameter limits must not be checked. This prevents the display of error messages when a setting command causes a conflict that is resolved by a subsequent setting command. See *SYSTEM:TRANsaction:END*.

SYSTem:TRANsaction:END

SYSTEM:TRANsaction:END marks the end of a sequence of setting commands between which the parameter limits must not be checked. After this command, the parameter limits are checked.

TEST

Table 6-6 Commands of the *TEST* system

Command	Parameter	Unit	Remarks
TEST:SENSor?			Query only

TEST:SENSor?

TEST:SENSor? triggers a selftest of the sensor. In contrast to **TST*, this command yields detailed information, which is useful for troubleshooting.

No signal may be applied to the sensor while the selftest is running.

If the selftest is carried out with a signal being present, error messages may erroneously be output for the test steps "Offset Voltages" and/or "Noise Voltages".

TRIGger

Table 6-7 Commands of the *TRIGger* system

Command	Parameter	Unit	Remarks
ABORt			No query
INITiate			
:CONTinuous[?]	OFF | ON		
:IMMediate			No query
TRIGger			
:COUNt[?]	1 to 2^{31}		
:DELay[?]	0 to 100.0	s	
:AUTO[?]	OFF | ON		
:HOLDoff[?]	0.0 to 10.0	s	
:HYSTeresis[?]	0.0 to 10.0	dB	
:IMMediate			No query
:LEVel[?]	x to y	W	
:SLOPe[?]	POSitive | NEGative		
:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		

ABORt

ABORt interrupts the current measurement and sets the sensor to the *IDLE* state (normal case). However, if the sensor is in the continuous measurement mode (setting *INITiate:CONTinuous ON*), the *IDLE* state is immediately exited and the sensor enters the *WAIT_FOR_TRIGGER* state.

INITiate:CONTinuous[?] OFF | ON

INITiate:CONTinuous ON activates the continuous measurement mode. In this mode, a new measurement cycle is automatically started after the previous one has been terminated. The sensor first enters the *WAIT_FOR_TRIGGER* state and begins with the measurement as soon as the trigger condition is fulfilled. Depending on the number of trigger events that are required for the final measurement result, e.g. in the case of averaging, the *WAIT_FOR_TRIGGER* state can be entered several times before a measurement result is output. Once the entire measurement cycle is completed, the sensor also enters the *WAIT_FOR_TRIGGER* state and – assuming continuous trigger events – will continue measuring.

If the continuous measurement mode is switched off by means of the *INITiate:CONTinuous OFF* command, single measurements can be started with the *INITiate:IMMediate* command (see below). After triggering and completion of the measurement, the sensor enters the *IDLE* state and remains in this state until a new measurement is started with the *INITiate:IMMediate* command.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

INITiate:IMMediate

INITiate:IMMediate starts a single measurement cycle. The sensor first changes from the *IDLE* state to the *WAIT_FOR_TRIGGER* state and begins the measurement as soon as the trigger condition is fulfilled. Depending on the number of trigger events that are required, e.g. for averaging, the *WAIT_FOR_TRIGGER* state can be entered several times. Once the entire measurement is completed, a measurement result is available and the sensor enters the *IDLE* state again. The *INITiate:IMMediate* command should only be used after the continuous measurement mode has been switched off with the *INITiate:CONTinuous OFF command*.

TRIGger:COUNt[?] 1 to 2^{31}

This setting is designed for applications in which several consecutive measurements have to be performed by sending the *INITiate:IMMediate* command only once, e.g. to obtain a higher measurement speed. The gap between a single measurement and the continuous measurement mode is thus closed. The number of measurements is defined with the parameter associated with the *TRIGger:COUNt* command. This number equals the number of results yielded by the sensor at the end of the measurement. A measurement result can contain several numeric results, e.g. power values for the points of a trace.

The TRIGger:COUNt *command does not define the number of trigger events required for performing the entire measurement task. The number is either identical or a whole-number multiple, if averaging was activated.*

A further increase in the measurement speed can be obtained by combining the mode used with the buffered mode. The results are not made available immediately but as a block at the end of the measurement sequence (see group commands SENSe:POWer:AVG:BUFFer).

The query yields the number of measurements performed with the *INIT:IMMediate* command after a measurement start.

Default setting: *1*

TRIGger:DELay[?] 0 to 100.0

TRIGger:DELay defines the delay (in seconds) between the occurrence of the trigger event and the beginning of the measurement itself.

Any trigger delay that is set comes into effect irrespective of the defined trigger source, but this is only useful with the *Internal* und *External* settings.

The query yields the set trigger delay (in seconds).

Default setting: *0.0 [s]*

TRIGger:DELay:AUTO[?] OFF | ON

TRIGger:DELay:AUTO ON ensures by means of an automatically determined delay that a measurement is only started after the sensor has settled. The power sensor R&S NRP-Z92 needs up to 20 ms to fully settle after a sharp change of the input power. If the automatic trigger delay was activated with the *TRIGger:DELay:AUTO ON* command, it has the following effect:

After exiting the *WAIT_FOR_TRIGGER* state – initiated by the trigger event – the first analog-digital conversion is not performed until the settling time of the sensor has elapsed once. If the measurement cycle has to be repeated due to an averaging factor other than one, no further delay occurs.

The auto-delay function takes delays within the sensor into account, so long as the level change is not greater than 10 dB. In the case of greater level changes, particularly abrupt jumps from high to low powers immediately before the trigger point, the *TRIGger:DELay* function must be used to provide a longer delay so that the specified accuracy can be attained. The automatically determined delay is ignored if a longer period was set with *TRIGger:DELay*.

TRIGger:DELay:AUTO OFF deactivates the automatic trigger delay.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *ON*

TRIGger:HOLDoff[?] 0.0 to 10.0

TRIGger:HOLDoff suppresses trigger events within the set holdoff time (in s), starting from the time of the last successful triggering.

The query yields the set holdoff time (in s).

Default setting: *0.0 [s]*

TRIGger:HYSTeresis[?] 0.0 to 10.0

TRIGger:HYSTeresis sets the hysteresis of the internal trigger threshold (parameter *TRIGger:LEVel*). Hysteresis is the magnitude (in dB) by which the trigger signal level falls below the trigger threshold (with positive trigger edge) to enable triggering again. The case is exactly the opposite with a negative trigger edge. The trigger hysteresis setting is only relevant to the *INTernal* trigger source.

The query yields the trigger hysteresis in dB.

Default setting: *0.0 [dB]*

TRIGger:IMMediate

TRIGger:IMMediate triggers a generic trigger event that causes the power sensor to exit immediately the *WAIT_FOR_TRIGGER* state irrespective of the trigger source and the trigger delay and begin with the measurement. The command is the only means of starting a measurement when the trigger source is set to *HOLD*. Only one measurement cycle is performed, irrespective of the set averaging factor.

TRIGger:LEVel[?] x to y

TRIGger:LEVel sets the trigger threshold for internal triggering derived from the test signal (in W). This setting is irrelevant to all other trigger sources. If an s-parameter device is active and/or if a component with a global offset upstream from the sensor is considered, the currently effective trigger threshold as

well as a trigger threshold to be input are referenced to the appropriately shifted sensor interface. When the s-parameter device and the offset correction are switched off, then the trigger threshold and its input limits are adjusted as necessary.

The query yields the currently effective trigger threshold in W.

Lower limit x and upper limit y of the trigger threshold
SENSe:CORRection:OFFSet:STATe ***OFF***:
x = <lower test limit in W> × 500
y = <upper test limit in W>

SENSe:CORRection:OFFSet:STATe ***ON***:
x = <lower test limit in W> × $500 \times 10^{OFFSET / 10\ dB}$
y = <upper test limit in W> × $10^{OFFSET / 10\ dB}$

<lower test limit in W>: The nominal lower test limit of the sensor or of the twoport/sensor combination (with activated s-parameter correction)
<upper test limit in W>: The nominal upper test limit of the sensor or of the twoport/sensor combination (with activated s-parameter correction)

The nominal test limits can be read out with the *SYSTem:INFO? "MINPOWER"* and *SYSTem:INFO? "MAXPOWER"* command.

Default setting: 10 × x

TRIGger:SLOPe[?] POSitive | NEGative

TRIGger:SLOPe defines the edge of the trigger event with internal and external triggering in the *Continuous Average, Timeslot Average,* and *Trace* modes. In this connection, positive means increasing envelope power (with internal triggering) or increasing voltage (with external triggering). As in the *Burst Average* mode, this command has no effect in conjunction with trigger sources *BUS*, *HOLD* and *IMMediate.*

The query yields
- *1* for *POSitive*,
- *2* for *NEGative*.

Default setting: *POSitive*

TRIGger:SOURce[?] HOLD | IMMediate | INTernal | BUS | EXTernal |

TRIGger:SOURce sets the trigger source.

- *HOLD*: Triggering only with command *TRIGger:IMMediate*.
- *IMMediate*: Automatic triggering without explicit event.
- *INTernal*: Triggering by the measurement signal. Relevant parameters: *TRIGger:LEVel, TRIGger:SLOPe, TRIGger:DELay, TRIGger:HYSTeresis, TRIGger:HOLDoff*.
- *BUS*: Triggering with command **TRG* or *TRIGger:IMMediate*.
- *EXTernal*: Triggering via the hardware trigger bus, e.g. via the R&S NRP-Z3 USB adapter or the R&S NRP base unit. Relevant parameters: *TRIGger:SLOPe, TRIGger:DELay, TRIGger:HOLDoff*.

The query yields

- *1* for *HOLD,*
- *2* for *IMMediate,*
- *4* for *INTernal,*
- *8* for *BUS,*
- *16* for *EXTernal.*

Default setting: *IMMediate*

List of Remote-Control Commands

The remote-control commands of the R&S NRP-Z92 have a syntax based on standard SCPI 1999.0, but they comply with it only to a limited extent.

Table 6-8 List of remote-control commands

Command	Parameter	Unit	Default setting	Page
*** Commands**				
*IDN?				6.2
*RST				6.2
*TRG				6.2
*TST?				6.2
CALibration Commands				
CALibration:DATA[?]	<calibration data set as definite length block>			6.3
CALibration:DATA:LENGth?		Bytes		6.3
CALibration:ZERO:AUTO[?]	OFF | ON | ONCE		OFF (fixed)	6.4
SENSe Commands				
SENSe:AVERage:COUNt[?]	1 to 65536		4	6.6
SENSe:AVERage:COUNt:AUTO[?]	OFF | ON | ONCE		ON	6.6
SENSe:AVERage:COUNt:AUTO:MTIMe[?]	0.01 to 999.99	s	4.0	6.7
SENSe:AVERage:COUNt:AUTO:NSRatio[?]	0.0 to 1.0	dB	0.01	6.7
SENSe:AVERage:COUNt:AUTO:RESolution[?]	1 to 4		3	6.7
SENSe:AVERage:COUNt:AUTO:TYPE[?]	RESolution | NSRatio		RESolution	6.7
SENSe:AVERage:RESet				6.7
SENSe:AVERage:STATe[?]	OFF | ON		ON	6.7
SENSe:AVERage:TCONtrol[?]	MOVing | REPeat		REPeat	6.8
SENSe:CORRection:DCYCle[?]	0.001 to 99.999	%	1.0	6.8
SENSe:CORRection:DCYCle:STATe[?]	OFF | ON		OFF	6.8
SENSe:CORRection:OFFSet[?]	–200.0 to 200.0	dB	0.0	6.9

Command	Parameter	Unit	Default setting	Page
SENSe:CORRection:OFFSet:STATe[?]	OFF | ON		OFF	6.9
SENSe:CORRection:SPDevice:STATe[?]	OFF | ON		ON (can be modified by the user)	6.9
SENSe:FREQuency[?]	9.0e3 to 6.0e9	Hz	50.0e6	6.9
SENSe:FUNCtion[?]	"POWer:AVG"		"POWer:AVG"	6.10
SENSe:POWer:AVG:APERture[?]	10.0e–6 to 0.3	s	0.02	6.10
SENSe:POWer:AVG:BUFFer:SIZE[?]	1 to 1024		1	6.10
SENSe:POWer:AVG:BUFFer:STATe[?]	OFF | ON		OFF	6.11
SENSe:POWer:AVG:SMOothing:STATe[?]	OFF | ON		ON	6.11
SENSe:SGAMma:CORRection:STATe[?]	OFF | ON		OFF	6.11
SENSe:SGAMma:MAGNitude[?]	0.0 to 1.0		0.0	6.12
SENSe:SGAMma:PHASe[?]	–360.0 to 360.0	degree	0.0	6.12
SYSTem Commands				
SYSTem:INFO? [Item]				6.13
SYSTem:INITialize				6.15
SYSTem:MINPower?		W		6.15
SYSTem:RUTime	0.0 to 10.0	s	0.1	6.15
SYSTem:SUTime	0.0 to 10.0	s	0.0001	6.15
SYSTem:TRANsaction:BEGin				6.15
SYSTem:TRANsaction:END				6.16
Test Commands				
TEST:SENSor?				6.17
Triggersystem Commands				
ABORt				6.18
INITiate:CONTinuous[?]	OFF | ON		OFF	6.18
INITiate:IMMediate				6.19
TRIGger:COUNt[?]	1 to 2^{31}		1	6.18
TRIGger:DELay[?]	0 to 100.0	s	0.0	6.19

Command	Parameter	Unit	Default setting	Page
TRIGger:DELay:AUTO[?]	OFF | ON		OFF	6.20
TRIGger:HOLDoff[?]	0.0 to 10.0	s	0.0	6.20
TRIGger:HYSTeresis[?]	0.0 to 10.0	dB	0.0	6.20
TRIGger:IMMediate				6.20
TRIGger:LEVel[?]	x to y	W	10 × x	6.20
TRIGger:SLOPe[?]	POSitive | NEGative		POSitive	6.21
TRIGger:SOURce[?]	HOLD | IMMediate | INTernal | BUS | EXTernal		IMMediate	6.21