R&S®NRPxxS[N]
Power Sensors
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following R&S® power sensors:

- R&S®NRP8S (1419.0006.02)
- R&S®NRP8SN (1419.0012.02)
- R&S®NRP18S (1419.0029.02)
- R&S®NRP18SN (1419.0035.02)
- R&S®NRP33S (1419.0064.02)
- R&S®NRP33SN (1419.0070.02)
- R&S®NRP33SN-V (1419.0129.02)
- R&S®NRP40S (1419.0041.02)
- R&S®NRP40SN (1419.0058.02)
- R&S®NRP50S (1419.0087.02)
- R&S®NRP50SN (1419.0093.02)

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this manual: R&S®NRPxxS[N] Power Sensors is abbreviated as R&S NRPxxS[N] Power Sensors, R&S®NRP-Zxx Power Sensor is abbreviated as R&S NRP-Zxx Power Sensor, R&S®NRPxSN Web GUI is abbreviated as R&S NRPxSN Web GUI, R&S®NRP2 is abbreviated as R&S NRP2, R&S®NRPV is abbreviated as R&S NRPV.

Basic Safety Instructions

Always read through and comply with the following safety instructions!

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standards of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment they require are designed, built and tested in accordance with the safety standards that apply in each case. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed, built 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, you must 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 any purpose 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.

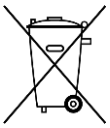
The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English. 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.

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 and when using the product. It is also absolutely essential to observe the additional safety instructions on personal safety, for example, 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. For product-specific information, see the data sheet and the product documentation.

Safety labels on products

The following safety labels are used on products to warn against risks and dangers.

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation		ON/OFF Power
	Caution when handling heavy equipment		Standby indication
	Danger of electric shock		Direct current (DC)

Symbol	Meaning	Symbol	Meaning
	Caution ! Hot surface		Alternating current (AC)
	Protective conductor terminal To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth		Direct/alternating current (DC/AC)
	Earth (Ground)		Class II Equipment to identify equipment meeting the safety requirements specified for Class II equipment (device protected by double or reinforced insulation)
	Frame or chassis Ground terminal		EU labeling for batteries and accumulators For additional information, see section "Waste disposal/Environmental protection", item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section "Waste disposal/Environmental protection", item 2.
	Warning! Laser radiation For additional information, see section "Operation", item 7.		

Signal words and their meaning

The following signal words are used in the product documentation in order to warn the reader about risks and dangers.

DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE Indicates information considered important, but not hazard-related, e.g. messages relating to property damage.
In the product documentation, the word ATTENTION is used synonymously.

These signal words 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 signal words described here are always used only in connection with the related product documentation and the related product. The use of signal words in connection with unrelated products or documentation can result in misinterpretation and in personal injury or material damage.

Operating states and operating positions

The product may be operated only under the operating conditions and in the positions specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury or death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, use only indoors, max. operating 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 ±5 % to the nominal frequency, overvoltage category 2, pollution degree 2.
2. 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). An installation that is not carried out as described in the product documentation could result in personal injury or even death.
3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

If the information on electrical safety is not observed either at all or to the extent necessary, electric shock, fire and/or serious personal injury or death may occur.

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the mains-supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a protective conductor contact and protective conductor.
3. Intentionally breaking the protective conductor 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.
4. If there is no power switch for disconnecting the product from the mains, or if the power switch is not suitable for this purpose, use the plug of the connecting cable to disconnect the product from the mains. In such cases, always ensure that the power plug is easily reachable and accessible at all times. For example, if the power plug is the disconnecting device, the length of the connecting cable must not exceed 3 m. Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, the disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cables on a regular basis to ensure that they are 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, for example, tripping over the cable or suffering an electric shock.

6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC 60950-1 / EN 60950-1 or IEC 61010-1 / EN 61010-1 standards that apply in each case.
11. 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.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

1. Operating the products requires special training and intense concentration. Make sure that persons who use the products are physically, mentally and emotionally fit enough to do so; otherwise, injuries or material damage may occur. It is the responsibility of the employer/operator to select suitable personnel for operating the products.

2. Before you move or transport the product, read and observe the section titled "Transport".
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.
4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal/Environmental protection", item 1.
5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.
6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
7. Laser products are given warning labels that are standardized according to their laser class. Lasers can cause biological harm due to the properties of their radiation and due to their extremely concentrated electromagnetic power. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).
8. EMC classes (in line with EN 55011/CISPR 11, and analogously with EN 55022/CISPR 22, EN 55032/CISPR 32)
   - Class A equipment:
     Equipment suitable for use in all environments except residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings
     Note: Class A equipment is intended for use in an industrial environment. This equipment may cause radio disturbances in residential environments, due to possible conducted as well as radiated disturbances. In this case, the operator may be required to take appropriate measures to eliminate these disturbances.
   - Class B equipment:
     Equipment suitable for use in residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings

Repair and service

1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.

2. Adjustments, replacement of parts, maintenance and repair may be performed only by electrical experts 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, protective conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

Batteries and rechargeable batteries/cells

If the information regarding batteries and rechargeable batteries/cells is not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury, and, in some cases, death. Batteries and rechargeable batteries with alkaline electrolytes (e.g. lithium cells) must be handled in accordance with the EN 62133 standard.

1. Cells must not be taken apart or crushed.
2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.
3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.
4. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
5. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.
6. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde & Schwarz type (see parts list) in order to ensure the safety of the product.
7. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.
2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.
3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

Waste disposal/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde & Schwarz customer service center.
2. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste, but must be collected separately.
   Rohde & Schwarz GmbH & Co. KG has developed a disposal concept and takes full responsibility for take-back obligations and disposal obligations for manufacturers within the EU. Contact your Rohde & Schwarz customer service center for environmentally responsible disposal of the product.
3. If products or their components are mechanically and/or thermally 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 by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
4. If handling the product releases 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. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

For additional information about environmental protection, visit the Rohde & Schwarz website.

Instrucciones de seguridad elementales

¡Es imprescindible leer y cumplir las siguientes instrucciones e informaciones de seguridad!

El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestro sistema de garantía de calidad controla constantemente que sean cumplidas estas normas. El presente producto ha sido fabricado y examinado según el certificado de conformidad de la UE y ha salido de nuestra planta en estado impecable según los estándares técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, el usuario deberá atenerse a todas las indicaciones, informaciones de seguridad y notas de alerta. El grupo de empresas Rohde & Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

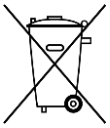
Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda sufrir daño. El uso del producto fuera de sus fines definidos o sin tener en cuenta las instrucciones del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del mal uso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto hace necesarios conocimientos técnicos y ciertos conocimientos del idioma inglés. Por eso se debe tener en cuenta que el producto solo pueda ser operado por personal especializado o personas instruidas en profundidad con las capacidades correspondientes. Si fuera necesaria indumentaria de seguridad para el uso de productos de Rohde & Schwarz, encontraría la información debida en la documentación del producto en el capítulo correspondiente. Guarde bien las informaciones de seguridad elementales, así como la documentación del producto, y entréguelas a usuarios posteriores.

Tener en cuenta las informaciones de seguridad sirve para evitar en lo posible lesiones o daños por peligros de toda clase. Por eso es imprescindible leer detalladamente y comprender por completo las siguientes informaciones de seguridad antes de usar el producto, y respetarlas durante el uso del producto. Deberán tenerse en cuenta todas las demás informaciones de seguridad, como p. ej. las referentes a la protección de personas, que encontrarán en el capítulo correspondiente de la documentación del producto y que también son de obligado cumplimiento. En las presentes informaciones de seguridad se recogen todos los objetos que distribuye el grupo de empresas Rohde & Schwarz bajo la denominación de "producto", entre ellos también aparatos, instalaciones así como toda clase de accesorios. Los datos específicos del producto figuran en la hoja de datos y en la documentación del producto.

Señalización de seguridad de los productos

Las siguientes señales de seguridad se utilizan en los productos para advertir sobre riesgos y peligros.

Símbolo	Significado	Símbolo	Significado
	Aviso: punto de peligro general Observar la documentación del producto		Tensión de alimentación de PUESTA EN MARCHA / PARADA
	Atención en el manejo de dispositivos de peso elevado		Indicación de estado de espera (standby)
	Peligro de choque eléctrico		Corriente continua (DC)
	Advertencia: superficie caliente		Corriente alterna (AC)
	Conexión a conductor de protección		Corriente continua / Corriente alterna (DC/AC)
	Conexión a tierra		El aparato está protegido en su totalidad por un aislamiento doble (reforzado)
	Conexión a masa		Distintivo de la UE para baterías y acumuladores Más información en la sección "Eliminación/protección del medio ambiente", punto 1.

Símbolo	Significado	Símbolo	Significado
	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)		Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos Más información en la sección "Eliminación/protección del medio ambiente", punto 2.
	Advertencia: rayo láser Más información en la sección "Funcionamiento", punto 7.		

Palabras de señal y su significado

En la documentación del producto se utilizan las siguientes palabras de señal con el fin de advertir contra riesgos y peligros.

Indica una situación de peligro que, si no se evita, causa lesiones graves o incluso la muerte.

Indica una situación de peligro que, si no se evita, puede causar lesiones graves o incluso la muerte.

Indica una situación de peligro que, si no se evita, puede causar lesiones leves o moderadas.

Indica información que se considera importante, pero no en relación con situaciones de peligro; p. ej., avisos sobre posibles daños materiales.
En la documentación del producto se emplea de forma sinónima el término CUIDADO.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el área económica europea. Pueden existir definiciones diferentes a esta definición en otras áreas económicas o en aplicaciones militares. Por eso se deberá tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación del producto y solamente en combinación con el producto correspondiente. La utilización de las palabras de señal en combinación con productos o documentaciones que no les correspondan puede llevar a interpretaciones equivocadas y tener por consecuencia daños en personas u objetos.

Estados operativos y posiciones de funcionamiento

El producto solamente debe ser utilizado según lo indicado por el fabricante respecto a los estados operativos y posiciones de funcionamiento sin que se obstruya la ventilación. Si no se siguen las indicaciones del fabricante, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte. En todos los trabajos deberán ser tenidas en cuenta las normas nacionales y locales de seguridad del trabajo y de prevención de accidentes.

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de ±10 % sobre el voltaje nominal y de ±5 % sobre la frecuencia nominal. Categoría de sobrecarga eléctrica 2, índice de suciedad 2.
2. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptos para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (p. ej. paredes y estantes). Si se realiza la instalación de modo distinto al indicado en la documentación del producto, se pueden causar lesiones o, en determinadas circunstancias, incluso la muerte.
3. No ponga el producto sobre aparatos que generen calor (p. ej. radiadores o calefactores). La temperatura ambiente no debe superar la temperatura máxima especificada en la documentación del producto o en la hoja de datos. En caso de sobrecalentamiento del producto, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

Seguridad eléctrica

Si no se siguen (o se siguen de modo insuficiente) las indicaciones del fabricante en cuanto a seguridad eléctrica, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.
2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.
3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.
4. Si el producto no está equipado con un interruptor para desconectarlo de la red, o bien si el interruptor existente no resulta apropiado para la desconexión de la red, el enchufe del cable de conexión se deberá considerar como un dispositivo de desconexión.
   El dispositivo de desconexión se debe poder alcanzar fácilmente y debe estar siempre bien accesible. Si, p. ej., el enchufe de conexión a la red es el dispositivo de desconexión, la longitud del cable de conexión no debe superar 3 m).
   Los interruptores selectores o electrónicos no son aptos para el corte de la red eléctrica. Si se integran productos sin interruptor en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.
5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.

6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).
7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.
8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.
9. En las mediciones en circuitos de corriente con una tensión U_{eff} > 30 V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.
12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.
14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.
15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.
16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.
17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.
18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.
2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".
3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados —los llamados alérgenos (p. ej. el níquel)—. Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.
4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación/protección del medio ambiente", punto 1.
5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.
6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.
7. Los productos con láser están provistos de indicaciones de advertencia normalizadas en función de la clase de láser del que se trate. Los rayos láser pueden provocar daños de tipo biológico a causa de las propiedades de su radiación y debido a su concentración extrema de potencia electromagnética. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).
8. Clases de compatibilidad electromagnética (conforme a EN 55011 / CISPR 11; y en analogía con EN 55022 / CISPR 22, EN 55032 / CISPR 32)
   - Aparato de clase A:
     Aparato adecuado para su uso en todos los entornos excepto en los residenciales y en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.
     Nota: Los aparatos de clase A están destinados al uso en entornos industriales. Estos aparatos pueden causar perturbaciones radioeléctricas en entornos residenciales debido a posibles perturbaciones guiadas o radiadas. En este caso, se le podrá solicitar al operador que tome las medidas adecuadas para eliminar estas perturbaciones.
   - Aparato de clase B:
     Aparato adecuado para su uso en entornos residenciales, así como en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.

Reparación y mantenimiento

1. El producto solamente debe ser abierto por personal especializado con autorización para ello. Antes de manipular el producto o abrirlo, es obligatorio desconectarlo de la tensión de alimentación, para evitar toda posibilidad de choque eléctrico.
2. El ajuste, el cambio de partes, el mantenimiento y la reparación deberán ser efectuadas solamente por electricistas autorizados por Rohde & Schwarz. Si se reponen partes con importancia para los aspectos de seguridad (p. ej. el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Después de cada cambio de partes relevantes para la seguridad deberá realizarse un control de seguridad (control a primera vista, control del conductor de protección, medición de resistencia de aislamiento, medición de la corriente de fuga, control de funcionamiento). Con esto queda garantizada la seguridad del producto.

Baterías y acumuladores o celdas

Si no se siguen (o se siguen de modo insuficiente) las indicaciones en cuanto a las baterías y acumuladores o celdas, pueden producirse explosiones, incendios y/o lesiones graves con posible consecuencia de muerte. El manejo de baterías y acumuladores con electrolitos alcalinos (p. ej. celdas de litio) debe seguir el estándar EN 62133.

1. No deben desmontarse, abrirse ni triturarse las celdas.
2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.
3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.
4. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.
5. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.
6. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).
7. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

Transporte

1. El producto puede tener un peso elevado. Por eso es necesario desplazarlo o transportarlo con precaución y, si es necesario, usando un sistema de elevación adecuado (p. ej. una carretilla elevadora), a fin de evitar lesiones en la espalda u otros daños personales.

2. Las asas instaladas en los productos sirven solamente de ayuda para el transporte del producto por personas. Por eso no está permitido utilizar las asas para la sujeción en o sobre medios de transporte como p. ej. grúas, carretillas elevadoras de horquilla, carros etc. Es responsabilidad suya fijar los productos de manera segura a los medios de transporte o elevación. Para evitar daños personales o daños en el producto, siga las instrucciones de seguridad del fabricante del medio de transporte o elevación utilizado.
3. Si se utiliza el producto dentro de un vehículo, recae de manera exclusiva en el conductor la responsabilidad de conducir el vehículo de manera segura y adecuada. El fabricante no asumirá ninguna responsabilidad por accidentes o colisiones. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Asegure el producto dentro del vehículo debidamente para evitar, en caso de un accidente, lesiones u otra clase de daños.

Eliminación/protección del medio ambiente

1. Los dispositivos marcados contienen una batería o un acumulador que no se debe desechar con los residuos domésticos sin clasificar, sino que debe ser recogido por separado. La eliminación se debe efectuar exclusivamente a través de un punto de recogida apropiado o del servicio de atención al cliente de Rohde & Schwarz.
2. Los dispositivos eléctricos usados no se deben desechar con los residuos domésticos sin clasificar, sino que deben ser recogidos por separado.
   Rohde & Schwarz GmbH & Co.KG ha elaborado un concepto de eliminación de residuos y asume plenamente los deberes de recogida y eliminación para los fabricantes dentro de la UE. Para desechar el producto de manera respetuosa con el medio ambiente, diríjase a su servicio de atención al cliente de Rohde & Schwarz.
3. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.
4. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

Se puede encontrar más información sobre la protección del medio ambiente en la página web de Rohde & Schwarz.

Grundlegende Sicherheitshinweise

Lesen und beachten Sie unbedingt die nachfolgenden Anweisungen und Sicherheitshinweise!

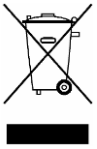
Alle Werke und Standorte der Rohde & Schwarz Firmengruppe sind ständig bemüht, den Sicherheitsstandard unserer Produkte auf dem aktuellsten Stand zu halten und unseren Kunden ein höchstmögliches Maß an Sicherheit zu bieten. Unsere Produkte und die dafür erforderlichen Zusatzgeräte werden entsprechend der jeweils gültigen Sicherheitsvorschriften gebaut und geprüft. Die Einhaltung dieser Bestimmungen wird durch unser Qualitätssicherungssystem laufend überwacht. Das vorliegende Produkt ist gemäß beiliegender EU-Konformitätsbescheinigung gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Benutzer alle Hinweise, Warnhinweise und Warnvermerke beachten. Bei allen Fragen bezüglich vorliegender Sicherheitshinweise steht Ihnen die Rohde & Schwarz Firmengruppe jederzeit gerne zur Verfügung.

Darüber hinaus liegt es in der Verantwortung des Benutzers, das Produkt in geeigneter Weise zu verwenden. Das Produkt ist ausschließlich für den Betrieb in Industrie und Labor bzw., wenn ausdrücklich zugelassen, auch für den Feldeinsatz bestimmt und darf in keiner Weise so verwendet werden, dass einer Person/Sache Schaden zugefügt werden kann. Die Benutzung des Produkts außerhalb des bestimmungsgemäßen Gebrauchs oder unter Missachtung der Anweisungen des Herstellers liegt in der Verantwortung des Benutzers. Der Hersteller übernimmt keine Verantwortung für die Zweckentfremdung des Produkts.

Die bestimmungsgemäße Verwendung des Produkts wird angenommen, wenn das Produkt nach den Vorgaben der zugehörigen Produktdokumentation innerhalb seiner Leistungsgrenzen verwendet wird (siehe Datenblatt, Dokumentation, nachfolgende Sicherheitshinweise). Die Benutzung des Produkts erfordert Fachkenntnisse und zum Teil englische Sprachkenntnisse. Es ist daher zu beachten, dass das Produkt ausschließlich von Fachkräften oder sorgfältig eingewiesenen Personen mit entsprechenden Fähigkeiten bedient werden darf. Sollte für die Verwendung von Rohde & Schwarz-Produkten persönliche Schutzausrüstung erforderlich sein, wird in der Produktdokumentation an entsprechender Stelle darauf hingewiesen. Bewahren Sie die grundlegenden Sicherheitshinweise und die Produktdokumentation gut auf und geben Sie diese an weitere Benutzer des Produkts weiter.

Die Einhaltung der Sicherheitshinweise dient dazu, Verletzungen oder Schäden durch Gefahren aller Art auszuschließen. Hierzu ist es erforderlich, dass die nachstehenden Sicherheitshinweise vor der Benutzung des Produkts sorgfältig gelesen und verstanden sowie bei der Benutzung des Produkts beachtet werden. Sämtliche weitere Sicherheitshinweise wie z.B. zum Personenschutz, die an entsprechender Stelle der Produktdokumentation stehen, sind ebenfalls unbedingt zu beachten. In den vorliegenden Sicherheitshinweisen sind sämtliche von der Rohde & Schwarz Firmengruppe vertriebenen Waren unter dem Begriff „Produkt“ zusammengefasst, hierzu zählen u. a. Geräte, Anlagen sowie sämtliches Zubehör.

Symbole und Sicherheitskennzeichnungen

Symbol	Bedeutung	Symbol	Bedeutung
	Achtung, allgemeine Gefahrenstelle Produktdokumentation beachten		EIN-/AUS (Versorgung)
	Vorsicht beim Umgang mit Geräten mit hohem Gewicht		Stand-by-Anzeige
	Gefahr vor elektrischem Schlag		Gleichstrom (DC)
	Warnung vor heißer Oberfläche		Wechselstrom (AC)
	Schutzleiteranschluss		Gleichstrom/Wechselstrom (DC/AC)
	Erdungsanschluss		Gerät entspricht den Sicherheits-anforderungen an die Schutzklasse II (Gerät durchgehend durch doppelte / verstärkte Isolierung geschützt.
	Masseanschluss des Gestells oder Gehäuses		EU - Kennzeichnung für Batterien und Akkumulatoren. Das Gerät enthält eine Batterie bzw. einen Akkumulator. Diese dürfen nicht über unsortierten Siedlungsabfall entsorgt werden, sondern sollten getrennt gesammelt werden. Weitere Informationen siehe Seite 7.
	Achtung beim Umgang mit elektrostatisch gefährdeten Bauelementen		EU - Kennzeichnung für die getrennte Sammlung von Elektro- und Elektronikgeräten. Elektroaltgeräte dürfen nicht über unsortierten Siedlungsabfall entsorgt werden, sondern müssen getrennt gesammelt werden. Weitere Informationen siehe Seite 7.
	Warnung vor Laserstrahl Produkte mit Laser sind je nach ihrer Laser-Klasse mit genormten Warnhinweisen versehen. Laser können aufgrund der Eigenschaften ihrer Strahlung und aufgrund ihrer extrem konzentrierten elektromagnetischen Leistung biologische Schäden verursachen. Für zusätzliche Informationen siehe Kapitel „Betrieb“ Punkt 7.		

Signalworte und ihre Bedeutung

Die folgenden Signalworte werden in der Produktdokumentation verwendet, um vor Risiken und Gefahren zu warnen.

kennzeichnet eine unmittelbare Gefährdung mit hohem Risiko, die Tod oder schwere Körperverletzung zur Folge haben wird, wenn sie nicht vermieden wird.

kennzeichnet eine mögliche Gefährdung mit mittlerem Risiko, die Tod oder (schwere) Körperverletzung zur Folge haben kann, wenn sie nicht vermieden wird.

kennzeichnet eine Gefährdung mit geringem Risiko, die leichte oder mittlere Körperverletzungen zur Folge haben könnte, wenn sie nicht vermieden wird.

weist auf die Möglichkeit einer Fehlbedienung hin, bei der das Produkt Schaden nehmen kann.

Diese Signalworte entsprechen der im europäischen Wirtschaftsraum üblichen Definition für zivile Anwendungen. Neben dieser Definition können in anderen Wirtschaftsräumen oder bei militärischen Anwendungen abweichende Definitionen existieren. Es ist daher darauf zu achten, dass die hier beschriebenen Signalworte stets nur in Verbindung mit der zugehörigen Produktdokumentation und nur in Verbindung mit dem zugehörigen Produkt verwendet werden. Die Verwendung von Signalworten in Zusammenhang mit nicht zugehörigen Produkten oder nicht zugehörigen Dokumentationen kann zu Fehlinterpretationen führen und damit zu Personen- oder Sachschäden führen.

Betriebszustände und Betriebslagen

Das Produkt darf nur in den vom Hersteller angegebenen Betriebszuständen und Betriebslagen ohne Behinderung der Belüftung betrieben werden. Werden die Herstellerangaben nicht eingehalten, kann dies elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen. Bei allen Arbeiten sind die örtlichen bzw. landesspezifischen Sicherheits- und Unfallverhütungsvorschriften zu beachten.

1. Sofern nicht anders vereinbart, gilt für R&S-Produkte folgendes:
   als vorgeschriebene Betriebslage grundsätzlich Gehäuseboden unten, IP-Schutzart 2X, Verschmutzungsgrad 2, Überspannungskategorie 2, nur in Innenräumen verwenden, Betrieb bis 2000 m ü. NN, Transport bis 4500 m ü. NN, für die Nennspannung gilt eine Toleranz von ±10%, für die Nennfrequenz eine Toleranz von ±5%.
2. Stellen Sie das Produkt nicht auf Oberflächen, Fahrzeuge, Ablagen oder Tische, die aus Gewichts- oder Stabilitätsgründen nicht dafür geeignet sind. Folgen Sie bei Aufbau und Befestigung des Produkts an Gegenständen oder Strukturen (z.B. Wände und Regale) immer den Installationshinweisen des Herstellers. Bei Installation abweichend von der Produktdokumentation können Personen verletzt, unter Umständen sogar getötet werden.
3. Stellen Sie das Produkt nicht auf hitzeerzeugende Gerätschaften (z.B. Radiatoren und Heizlüfter). Die Umgebungstemperatur darf nicht die in der Produktdokumentation oder im Datenblatt spezifizierte Maximaltemperatur überschreiten. Eine Überhitzung des Produkts kann elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen.

Elektrische Sicherheit

Werden die Hinweise zur elektrischen Sicherheit nicht oder unzureichend beachtet, kann dies elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen.

1. Vor jedem Einschalten des Produkts ist sicherzustellen, dass die am Produkt eingestellte Nennspannung und die Netznennspannung des Versorgungsnetzes übereinstimmen. Ist es erforderlich, die Spannungseinstellung zu ändern, so muss ggf. auch die dazu gehörige Netzsicherung des Produkts geändert werden.
2. Bei Produkten der Schutzklasse I mit beweglicher Netzzuleitung und Gerätesteckvorrichtung ist der Betrieb nur an Steckdosen mit Schutzkontakt und angeschlossenem Schutzleiter zulässig.
3. Jegliche absichtliche Unterbrechung des Schutzleiters, sowohl in der Zuleitung als auch am Produkt selbst, ist unzulässig. Es kann dazu führen, dass von dem Produkt die Gefahr eines elektrischen Schlags ausgeht. Bei Verwendung von Verlängerungsleitungen oder Steckdosenleisten ist sicherzustellen, dass diese regelmäßig auf ihren sicherheitstechnischen Zustand überprüft werden.
4. Sofern das Produkt nicht mit einem Netzschalter zur Netztrennung ausgerüstet ist, beziehungsweise der vorhandene Netzschalter zu Netztrennung nicht geeignet ist, so ist der Stecker des Anschlusskabels als Trennvorrichtung anzusehen.
   Die Trennvorrichtung muss jederzeit leicht erreichbar und gut zugänglich sein. Ist z.B. der Netzstecker die Trennvorrichtung, darf die Länge des Anschlusskabels 3 m nicht überschreiten.
   Funktionsschalter oder elektronische Schalter sind zur Netztrennung nicht geeignet. Werden Produkte ohne Netzschalter in Gestelle oder Anlagen integriert, so ist die Trennvorrichtung auf Anlagenebene zu verlagern.
5. Benutzen Sie das Produkt niemals, wenn das Netzkabel beschädigt ist. Überprüfen Sie regelmäßig den einwandfreien Zustand der Netzkabel. Stellen Sie durch geeignete Schutzmaßnahmen und Verlegearten sicher, dass das Netzkabel nicht beschädigt werden kann und niemand z.B. durch Stolperfallen oder elektrischen Schlag zu Schaden kommen kann.
6. Der Betrieb ist nur an TN/TT Versorgungsnetzen gestattet, die mit höchstens 16 A abgesichert sind (höhere Absicherung nur nach Rücksprache mit der Rohde & Schwarz Firmengruppe).
7. Stecken Sie den Stecker nicht in verstaubte oder verschmutzte Steckdosen/-buchsen. Stecken Sie die Steckverbindung/-vorrichtung fest und vollständig in die dafür vorgesehenen Steckdosen/-buchsen. Missachtung dieser Maßnahmen kann zu Funken, Feuer und/oder Verletzungen führen.
8. Überlasten Sie keine Steckdosen, Verlängerungskabel oder Steckdosenleisten, dies kann Feuer oder elektrische Schläge verursachen.
9. Bei Messungen in Stromkreisen mit Spannungen U_{eff} > 30 V ist mit geeigneten Maßnahmen Vorsorge zu treffen, dass jegliche Gefährdung ausgeschlossen wird (z.B. geeignete Messmittel, Absicherung, Strombegrenzung, Schutztrennung, Isolierung usw.).
10. Bei Verbindungen mit informationstechnischen Geräten, z.B. PC oder Industrierechner, ist darauf zu achten, dass diese der jeweils gültigen IEC 60950-1 / EN 60950-1 oder IEC 61010-1 / EN 61010-1 entsprechen.
11. Sofern nicht ausdrücklich erlaubt, darf der Deckel oder ein Teil des Gehäuses niemals entfernt werden, wenn das Produkt betrieben wird. Dies macht elektrische Leitungen und Komponenten zugänglich und kann zu Verletzungen, Feuer oder Schaden am Produkt führen.

12. Wird ein Produkt ortsfest angeschlossen, ist die Verbindung zwischen dem Schutzleiteranschluss vor Ort und dem Geräteschutzleiter vor jeglicher anderer Verbindung herzustellen. Aufstellung und Anschluss darf nur durch eine Elektrofachkraft erfolgen.
13. Bei ortsfesten Geräten ohne eingebaute Sicherung, Selbstschalter oder ähnliche Schutzeinrichtung muss der Versorgungskreis so abgesichert sein, dass alle Personen, die Zugang zum Produkt haben, sowie das Produkt selbst ausreichend vor Schäden geschützt sind.
14. Jedes Produkt muss durch geeigneten Überspannungsschutz vor Überspannung (z.B. durch Blitzschlag) geschützt werden. Andernfalls ist das bedienende Personal durch elektrischen Schlag gefährdet.
15. Gegenstände, die nicht dafür vorgesehen sind, dürfen nicht in die Öffnungen des Gehäuses eingebracht werden. Dies kann Kurzschlüsse im Produkt und/oder elektrische Schläge, Feuer oder Verletzungen verursachen.
16. Sofern nicht anders spezifiziert, sind Produkte nicht gegen das Eindringen von Flüssigkeiten geschützt, siehe auch Abschnitt "Betriebszustände und Betriebslagen", Punkt 1. Daher müssen die Geräte vor Eindringen von Flüssigkeiten geschützt werden. Wird dies nicht beachtet, besteht Gefahr durch elektrischen Schlag für den Benutzer oder Beschädigung des Produkts, was ebenfalls zur Gefährdung von Personen führen kann.
17. Benutzen Sie das Produkt nicht unter Bedingungen, bei denen Kondensation in oder am Produkt stattfinden könnte oder ggf. bereits stattgefunden hat, z.B. wenn das Produkt von kalter in warme Umgebung bewegt wurde. Das Eindringen von Wasser erhöht das Risiko eines elektrischen Schlages.
18. Trennen Sie das Produkt vor der Reinigung komplett von der Energieversorgung (z.B. speisendes Netz oder Batterie). Nehmen Sie bei Geräten die Reinigung mit einem weichen, nicht fasernden Staublappen vor. Verwenden Sie keinesfalls chemische Reinigungsmittel wie z.B. Alkohol, Aceton, Nitroverdünnung.

Betrieb

1. Die Benutzung des Produkts erfordert spezielle Einweisung und hohe Konzentration während der Benutzung. Es muss sichergestellt sein, dass Personen, die das Produkt bedienen, bezüglich ihrer körperlichen, geistigen und seelischen Verfassung den Anforderungen gewachsen sind, da andernfalls Verletzungen oder Sachschäden nicht auszuschließen sind. Es liegt in der Verantwortung des Arbeitsgebers/Betreibers, geeignetes Personal für die Benutzung des Produkts auszuwählen.
2. Bevor Sie das Produkt bewegen oder transportieren, lesen und beachten Sie den Abschnitt "Transport".
3. Wie bei allen industriell gefertigten Gütern kann die Verwendung von Stoffen, die Allergien hervorrufen - so genannte Allergene (z.B. Nickel) - nicht generell ausgeschlossen werden. Sollten beim Umgang mit R&S-Produkten allergische Reaktionen, z.B. Hautausschlag, häufiges Niesen, Bindehautrötung oder Atembeschwerden auftreten, ist umgehend ein Arzt aufzusuchen, um die Ursachen zu klären und Gesundheitsschäden bzw. -belastungen zu vermeiden.
4. Vor der mechanischen und/oder thermischen Bearbeitung oder Zerlegung des Produkts beachten Sie unbedingt Abschnitt "Entsorgung", Punkt 1.

5. Bei bestimmten Produkten, z.B. HF-Funkanlagen, können funktionsbedingt erhöhte elektromagnetische Strahlungen auftreten. Unter Berücksichtigung der erhöhten Schutzwürdigkeit des ungeborenen Lebens müssen Schwangere durch geeignete Maßnahmen geschützt werden. Auch Träger von Herzschrittmachern können durch elektromagnetische Strahlungen gefährdet sein. Der Arbeitgeber/Betreiber ist verpflichtet, Arbeitsstätten, bei denen ein besonderes Risiko einer Strahlenexposition besteht, zu beurteilen und zu kennzeichnen und mögliche Gefahren abzuwenden.
6. Im Falle eines Brandes entweichen ggf. giftige Stoffe (Gase, Flüssigkeiten etc.) aus dem Produkt, die Gesundheitsschäden verursachen können. Daher sind im Brandfall geeignete Maßnahmen wie z.B. Atemschutzmasken und Schutzkleidung zu verwenden.
7. Falls ein Laser-Produkt in ein R&S-Produkt integriert ist (z.B. CD/DVD-Laufwerk), dürfen keine anderen Einstellungen oder Funktionen verwendet werden, als in der Produktdokumentation beschrieben, um Personenschäden zu vermeiden (z.B. durch Laserstrahl).
8. EMV Klassen (nach EN 55011 / CISPR 11; sinngemäß EN 55022 / CISPR 22, EN 55032 / CISPR 32)

   Gerät der Klasse A:
   Ein Gerät, das sich für den Gebrauch in allen anderen Bereichen außer dem Wohnbereich und solchen Bereichen eignet, die direkt an ein Niederspannungs-Versorgungsnetz angeschlossen sind, das Wohngebäude versorgt.
   Hinweis: Diese Einrichtung kann wegen möglicher auftretender leitungsgebundener als auch gestrahlten Störgrößen im Wohnbereich Funkstörungen verursachen. In diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen durchzuführen.
   Gerät der Klasse B:
   Ein Gerät, das sich für den Betrieb im Wohnbereich sowie in solchen Bereichen eignet, die direkt an ein Niederspannungs-Versorgungsnetz angeschlossen sind, das Wohngebäude versorgt.

Reparatur und Service

1. Das Produkt darf nur von dafür autorisiertem Fachpersonal geöffnet werden. Vor Arbeiten am Produkt oder Öffnen des Produkts ist dieses von der Versorgungsspannung zu trennen, sonst besteht das Risiko eines elektrischen Schlages.
2. Abgleich, Auswechseln von Teilen, Wartung und Reparatur darf nur von R&S-autorisierten Elektrofachkräften ausgeführt werden. Werden sicherheitsrelevante Teile (z.B. Netzschalter, Netztrafos oder Sicherungen) ausgewechselt, so dürfen diese nur durch Originalteile ersetzt werden. Nach jedem Austausch von sicherheitsrelevanten Teilen ist eine Sicherheitsprüfung durchzuführen (Sichtprüfung, Schutzleitertest, Isolationswiderstand-, Ableitstrommessung, Funktionstest). Damit wird sichergestellt, dass die Sicherheit des Produkts erhalten bleibt.

Batterien und Akkumulatoren/Zellen

Werden die Hinweise zu Batterien und Akkumulatoren/Zellen nicht oder unzureichend beachtet, kann dies Explosion, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen. Die Handhabung von Batterien und Akkumulatoren mit alkalischen Elektrolyten (z.B. Lithiumzellen) muss der EN 62133 entsprechen.

1. Zellen dürfen nicht zerlegt, geöffnet oder zerkleinert werden.
2. Zellen oder Batterien dürfen weder Hitze noch Feuer ausgesetzt werden. Die Lagerung im direkten Sonnenlicht ist zu vermeiden. Zellen und Batterien sauber und trocken halten. Verschmutzte Anschlüsse mit einem trockenen, sauberen Tuch reinigen.

3. Zellen oder Batterien dürfen nicht kurzgeschlossen werden. Zellen oder Batterien dürfen nicht gefahrbringend in einer Schachtel oder in einem Schubfach gelagert werden, wo sie sich gegenseitig kurzschließen oder durch andere leitende Werkstoffe kurzgeschlossen werden können. Eine Zelle oder Batterie darf erst aus ihrer Originalverpackung entnommen werden, wenn sie verwendet werden soll.
4. Zellen oder Batterien dürfen keinen unzulässig starken, mechanischen Stößen ausgesetzt werden.
5. Bei Undichtheit einer Zelle darf die Flüssigkeit nicht mit der Haut in Berührung kommen oder in die Augen gelangen. Falls es zu einer Berührung gekommen ist, den betroffenen Bereich mit reichlich Wasser waschen und ärztliche Hilfe in Anspruch nehmen.
6. Werden Zellen oder Batterien, die alkalische Elektrolyte enthalten (z.B. Lithiumzellen), unsachgemäß ausgewechselt oder geladen, besteht Explosionsgefahr. Zellen oder Batterien nur durch den entsprechenden R&S-Typ ersetzen (siehe Ersatzteilliste), um die Sicherheit des Produkts zu erhalten.
7. Zellen oder Batterien müssen wiederverwertet werden und dürfen nicht in den Restmüll gelangen. Akkumulatoren oder Batterien, die Blei, Quecksilber oder Cadmium enthalten, sind Sonderabfall. Beachten Sie hierzu die landesspezifischen Entsorgungs- und Recycling-Bestimmungen.

Transport

1. Das Produkt kann ein hohes Gewicht aufweisen. Daher muss es vorsichtig und ggf. unter Verwendung eines geeigneten Hebemittels (z.B. Hubwagen) bewegt bzw. transportiert werden, um Rückenschäden oder Verletzungen zu vermeiden.
2. Griffe an den Produkten sind eine Handhabungshilfe, die ausschließlich für den Transport des Produkts durch Personen vorgesehen ist. Es ist daher nicht zulässig, Griffe zur Befestigung an bzw. auf Transportmitteln, z.B. Kränen, Gabelstaplern, Karren etc. zu verwenden. Es liegt in Ihrer Verantwortung, die Produkte sicher an bzw. auf geeigneten Transport- oder Hebemitteln zu befestigen. Beachten Sie die Sicherheitsvorschriften des jeweiligen Herstellers eingesetzter Transport- oder Hebemittel, um Personenschäden und Schäden am Produkt zu vermeiden.
3. Falls Sie das Produkt in einem Fahrzeug benutzen, liegt es in der alleinigen Verantwortung des Fahrers, das Fahrzeug in sicherer und angemessener Weise zu führen. Der Hersteller übernimmt keine Verantwortung für Unfälle oder Kollisionen. Verwenden Sie das Produkt niemals in einem sich bewegenden Fahrzeug, sofern dies den Fahrzeugführer ablenken könnte. Sichern Sie das Produkt im Fahrzeug ausreichend ab, um im Falle eines Unfalls Verletzungen oder Schäden anderer Art zu verhindern.

Entsorgung

1. Batterien bzw. Akkumulatoren, die nicht mit dem Hausmüll entsorgt werden dürfen, darf nach Ende der Lebensdauer nur über eine geeignete Sammelstelle oder eine Rohde & Schwarz-Kundendienststelle entsorgt werden.
2. Am Ende der Lebensdauer des Produktes darf dieses Produkt nicht über den normalen Hausmüll entsorgt werden, sondern muss getrennt gesammelt werden.
   Rohde & Schwarz GmbH & Co.KG ein Entsorgungskonzept entwickelt und übernimmt die Pflichten der Rücknahme- und Entsorgung für Hersteller innerhalb der EU in vollem Umfang. Wenden Sie sich bitte an Ihre Rohde & Schwarz-Kundendienststelle, um das Produkt umweltgerecht zu entsorgen.

3. Werden Produkte oder ihre Bestandteile über den bestimmungsgemäßen Betrieb hinaus mechanisch und/oder thermisch bearbeitet, können ggf. gefährliche Stoffe (schwermetallhaltiger Staub wie z.B. Blei, Beryllium, Nickel) freigesetzt werden. Die Zerlegung des Produkts darf daher nur von speziell geschultem Fachpersonal erfolgen. Unsachgemäßes Zerlegen kann Gesundheitsschäden hervorrufen. Die nationalen Vorschriften zur Entsorgung sind zu beachten.
4. Falls beim Umgang mit dem Produkt Gefahren- oder Betriebsstoffe entstehen, die speziell zu entsorgen sind, z.B. regelmäßig zu wechselnde Kühlmittel oder Motorenöle, sind die Sicherheitshinweise des Herstellers dieser Gefahren- oder Betriebsstoffe und die regional gültigen Entsorgungsvorschriften einzuhalten. Beachten Sie ggf. auch die zugehörigen speziellen Sicherheitshinweise in der Produktdokumentation. Die unsachgemäße Entsorgung von Gefahren- oder Betriebsstoffen kann zu Gesundheitsschäden von Personen und Umweltschäden führen.

Weitere Informationen zu Umweltschutz finden Sie auf der Rohde & Schwarz Home Page.

Consignes de sécurité fondamentales

Lisez et respectez impérativement les instructions et consignes de sécurité suivantes

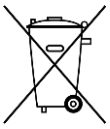
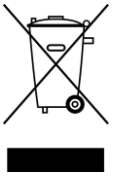
Les usines et sites du groupe Rohde & Schwarz veillent à la conformité des produits du groupe avec les normes de sécurité en vigueur dans un souci constant de garantir aux clients le plus haut niveau de sécurité possible. Nos produits ainsi que les accessoires nécessaires sont fabriqués et testés conformément aux règles de sécurité en vigueur. Le respect de ces règles est vérifié régulièrement par notre système d'assurance qualité. Le présent produit a été fabriqué et contrôlé conformément au certificat de conformité CE ci-joint et a quitté l'usine dans un parfait état de sécurité. Pour le maintenir dans cet état et en garantir une utilisation sans danger, l'utilisateur doit respecter l'ensemble des consignes, remarques de sécurité et avertissements qui se trouvent dans ce manuel. Le groupe Rohde & Schwarz se tient à votre disposition pour toutes questions relatives aux présentes consignes de sécurité.

Il incombe à l'utilisateur d'employer ce produit de manière appropriée. Le produit est exclusivement destiné à l'utilisation en industrie et en laboratoire et/ou, si cela a été expressément autorisé, également aux travaux extérieurs ; il ne peut en aucun cas être utilisé à des fins pouvant causer des dommages corporels ou matériels. L'exploitation du produit en dehors de son utilisation prévue ou le non-respect des consignes du fabricant se font sous la responsabilité de l'utilisateur. Le fabricant décline toute responsabilité en cas d'utilisation non conforme du produit.

Le produit est présumé faire l'objet d'une utilisation conforme lorsqu'il est utilisé conformément aux consignes de la documentation produit correspondante et dans la limite de ses performances (voir fiche technique, documentation, consignes de sécurité ci-après). L'utilisation du produit exige des compétences en la matière et des connaissances de base de l'anglais. Par conséquent, le produit ne devra être utilisé que par un personnel qualifié ou des personnes formées de manière approfondie et possédant les compétences requises. Si, pour l'utilisation des produits Rohde & Schwarz, l'emploi d'un équipement personnel de protection s'avère nécessaire, il en est fait mention dans la documentation produit à l'emplacement correspondant. Conservez les consignes de sécurité fondamentales et la documentation produit dans un lieu sûr et transmettez ces documents aux autres utilisateurs du produit.

La stricte observation des consignes de sécurité a pour but d'exclure des blessures ou dommages causés par des dangers de toutes sortes. A cet effet, il est nécessaire de lire avec soin et de bien comprendre les consignes de sécurité ci-dessous avant l'utilisation du produit et de les respecter lors de l'utilisation du produit. Toutes les autres consignes de sécurité présentées à l'emplacement correspondant de la documentation produit, par exemple, celles concernant la protection des personnes, doivent également être impérativement respectées. Dans les présentes consignes de sécurité, toutes les marchandises commercialisées par le groupe Rohde & Schwarz, notamment les appareils, les systèmes ainsi que les accessoires, sont dénommés « produit ».

Symboles et marquages de sécurité

Symbole	Signification	Symbole	Signification
	Avis, source générale de danger Se référer à la documentation produit		MARCHE / ARRET (tension d'alimentation)
	Attention lors de la manipulation d'appareils ayant un poids élevé		Indicateur de veille
	Risque de choc électrique		Courant continu (CC)
	Avertissement, surface chaude		Courant alternatif (CA)
	Borne de conducteur de protection		Courant continu/alternatif (CC/CA)
	Borne de mise à la terre		L'appareil est conforme aux exigences de sécurité du degré de protection II (appareil entièrement protégé par isolation double/renforcée).
	Borne de mise à la masse du bâti ou du boîtier		Marquage UE pour batteries et accumulateurs. L'appareil contient une batterie ou un accumulateur. Ces pièces ne peuvent pas être éliminées avec les déchets urbains non triés, mais doivent faire l'objet d'une collecte séparée. Pour plus d'informations, voir la page 7.
	Avis : prudence lors de la manipulation de composants sensibles aux décharges électrostatiques		Marquage UE pour la collecte séparée d'équipements électriques et électroniques. Les déchets d'équipements électriques et électroniques ne peuvent pas être éliminés avec les déchets urbains non triés, mais doivent faire l'objet d'une collecte séparée. Pour plus d'informations, voir la page 7.
	Avertissement, rayon laser Les produits laser sont munis d'avertissements normalisés d'après leur catégorie laser. En raison des caractéristiques de leur rayonnement ainsi que de leur puissance électromagnétique extrêmement concentrée, les lasers peuvent causer des dommages biologiques. Pour plus d'informations, voir le chapitre « Fonctionnement »", point 7.		

Mots d'alerte et significations

Les mots d'alerte suivants sont utilisés dans la documentation produit pour avertir des risques et dangers.

DANGER	Indique une situation dangereuse immédiate qui, si elle n'est pas évitée, comporte un risque élevé de blessures graves ou mortelles.
AVERTISSEMENT	Indique une situation dangereuse possible qui, si elle n'est pas évitée, comporte un risque modéré de blessures (graves) ou mortelles.
ATTENTION	Indique une situation dangereuse qui, si elle n'est pas évitée, comporte un risque faible de blessures mineures ou modérées.
AVIS	Indique la possibilité d'une fausse manœuvre susceptible d'endommager le produit.

Ces mots d'alerte correspondent à la définition habituelle utilisée pour des applications civiles dans l'espace économique européen. Des définitions divergentes peuvent cependant exister dans d'autres espaces économiques ou dans le cadre d'applications militaires. Il faut donc veiller à ce que les mots d'alerte décrits ici ne soient utilisés qu'en relation avec la documentation produit correspondante et seulement avec le produit correspondant. L'utilisation des mots d'alerte en relation avec des produits ou des documentations non correspondants peut conduire à des erreurs d'interprétation et par conséquent à des dommages corporels ou matériels.

États et positions de fonctionnement

L'appareil ne doit être utilisé que dans les états et positions de fonctionnement indiqués par le fabricant. Tout obstacle à la ventilation doit être empêché. Le non-respect des indications du fabricant peut provoquer des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort. Pour tous les travaux, les règles locales et/ou nationales de sécurité et de prévention des accidents doivent être respectées.

1. Sauf stipulations contraires, les produits Rohde & Schwarz répondent aux exigences ci-après : faire fonctionner le produit avec le fond du boîtier toujours en bas, degré de protection IP 2X, degré de pollution 2, catégorie de surtension 2, utilisation uniquement à l'intérieur, fonctionnement à une altitude max. de 2000 m au-dessus du niveau de la mer, transport à une altitude max. de 4500 m au-dessus du niveau de la mer, tolérance de ±10 % pour la tension nominale et de ±5 % pour la fréquence nominale.
2. Ne jamais placer le produit sur des surfaces, véhicules, dépôts ou tables non appropriés pour raisons de stabilité ou de poids. Suivre toujours strictement les indications d'installation du fabricant pour le montage et la fixation du produit sur des objets ou des structures (par exemple parois et étagères). En cas d'installation non conforme à la documentation produit, il y a risque de blessures, voire de mort.
3. Ne jamais placer le produit sur des dispositifs générant de la chaleur (par exemple radiateurs et appareils de chauffage soufflants). La température ambiante ne doit pas dépasser la température maximale spécifiée dans la documentation produit ou dans la fiche technique. Une surchauffe du produit peut provoquer des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort.

Sécurité électrique

Si les consignes relatives à la sécurité électrique ne sont pas ou sont insuffisamment respectées, il peut s'ensuivre des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort.

1. Avant chaque mise sous tension du produit, il faut s'assurer que la tension nominale réglée sur le produit correspond à la tension nominale du réseau électrique. S'il est nécessaire de modifier le réglage de la tension, il faut remplacer le fusible du produit, le cas échéant.
2. L'utilisation des produits du degré de protection I pourvus d'un câble d'alimentation mobile et d'un connecteur n'est autorisée qu'avec des prises munies d'un contact de protection et d'un conducteur de protection raccordé.
3. Toute déconnexion intentionnelle du conducteur de protection, dans le câble ou dans le produit lui-même, est interdite. Elle entraîne un risque de choc électrique au niveau du produit. En cas d'utilisation de câbles prolongateurs ou de multiprises, ceux-ci doivent être examinés régulièrement quant à leur état de sécurité technique.
4. Si le produit n'est pas doté d'un interrupteur d'alimentation pour le couper du réseau électrique ou si l'interrupteur d'alimentation disponible n'est pas approprié pour couper le produit du réseau électrique, le connecteur mâle du câble de raccordement est à considérer comme dispositif de séparation.
   Le dispositif de séparation doit être à tout moment facilement accessible. Si, par exemple, le connecteur d'alimentation sert de dispositif de séparation, la longueur du câble de raccordement ne doit pas dépasser 3 m.
   Les commutateurs fonctionnels ou électroniques ne sont pas appropriés pour couper l'appareil du réseau électrique. Si des produits sans interrupteur d'alimentation sont intégrés dans des bâtis ou systèmes, le dispositif de séparation doit être reporté au niveau du système.
5. Ne jamais utiliser le produit si le câble d'alimentation est endommagé. Vérifier régulièrement le parfait état du câble d'alimentation. Prendre les mesures préventives appropriées et opter pour des types de pose tels que le câble d'alimentation ne puisse pas être endommagé et que personne ne puisse subir de préjudice, par exemple en trébuchant sur le câble ou par des chocs électriques.
6. L'utilisation des produits est uniquement autorisée sur des réseaux d'alimentation de type TN/TT protégés par des fusibles d'une intensité max. de 16 A (pour toute intensité supérieure, consulter le groupe Rohde & Schwarz).
7. Ne pas brancher le connecteur dans des prises d'alimentation sales ou poussiéreuses. Enfoncer fermement le connecteur jusqu'au bout de la prise. Le non-respect de cette mesure peut provoquer des étincelles, incendies et/ou blessures.
8. Ne pas surcharger les prises, les câbles prolongateurs ou les multiprises, cela pouvant provoquer des incendies ou chocs électriques.
9. En cas de mesures sur les circuits électriques d'une tension efficace > 30 V, prendre les précautions nécessaires pour éviter tout risque (par exemple équipement de mesure approprié, fusibles, limitation de courant, coupe-circuit, isolation, etc.).
10. En cas d'interconnexion avec des équipements informatiques comme par exemple un PC ou un ordinateur industriel, veiller à ce que ces derniers soient conformes aux normes IEC 60950-1 / EN 60950-1 ou IEC 61010-1 / EN 61010-1 en vigueur.
11. Sauf autorisation expresse, il est interdit de retirer le couvercle ou toute autre pièce du boîtier lorsque le produit est en cours de service. Les câbles et composants électriques seraient ainsi accessibles, ce qui peut entraîner des blessures, des incendies ou des dégâts sur le produit.

12. Si un produit est connecté de façon stationnaire, établir avant toute autre connexion le raccordement du conducteur de protection local et du conducteur de protection du produit. L'installation et le raccordement ne peuvent être effectués que par un électricien ou électronicien qualifié.
13. Sur les appareils stationnaires sans fusible ni disjoncteur automatique ou dispositif de protection similaire intégrés, le circuit d'alimentation doit être sécurisé de sorte que toutes les personnes ayant accès au produit et le produit lui-même soient suffisamment protégés contre tout dommage.
14. Chaque produit doit être protégé de manière appropriée contre les éventuelles surtensions (par exemple dues à un coup de foudre). Sinon, les utilisateurs sont exposés à des risques de choc électrique.
15. Ne jamais introduire d'objets non prévus à cet effet dans les ouvertures du boîtier, étant donné que cela peut entraîner des courts-circuits dans le produit et/ou des chocs électriques, incendies ou blessures.
16. Sauf spécification contraire, les produits ne sont pas protégés contre l'infiltration de liquides, voir aussi la section « États et positions de fonctionnement », point 1. Il faut donc protéger les produits contre l'infiltration de liquides. La non-observation de cette consigne entraîne le risque de choc électrique pour l'utilisateur ou d'endommagement du produit, ce qui peut également mettre les personnes en danger.
17. Ne pas utiliser le produit dans des conditions pouvant occasionner ou ayant déjà occasionné, le cas échéant, des condensations dans ou sur le produit, par exemple lorsque celui-ci est déplacé d'un environnement froid dans un environnement chaud. L'infiltration d'eau augmente le risque de choc électrique.
18. Avant le nettoyage, débrancher le produit de l'alimentation (par exemple réseau électrique ou batterie). Pour le nettoyage des appareils, utiliser un chiffon doux non pelucheux. N'utiliser en aucun cas de produit de nettoyage chimique, tel que de l'alcool, de l'acétone ou un diluant nitrocellulosique.

Fonctionnement

1. L'utilisation du produit exige une formation spécifique ainsi qu'une grande concentration. Il est impératif que les personnes qui utilisent le produit présent les aptitudes physiques, mentales et psychiques requises, vu qu'autrement des dommages corporels ou matériels ne peuvent pas être exclus. Le choix du personnel qualifié pour l'utilisation du produit est sous la responsabilité de l'employeur/l'exploitant.
2. Avant de déplacer ou de transporter le produit, lire et respecter la section « Transport ».
3. Comme pour tous les biens produits de façon industrielle, l'utilisation de matériaux pouvant causer des allergies (allergènes, comme par exemple le nickel) ne peut être totalement exclue. Si, lors de l'utilisation de produits Rohde & Schwarz, des réactions allergiques surviennent, telles qu'éruption cutanée, éternuements fréquents, rougeur de la conjonctive ou difficultés respiratoires, il faut immédiatement consulter un médecin pour en clarifier la cause et éviter toute atteinte à la santé.
4. Avant le traitement mécanique et/ou thermique ou le démontage du produit, il faut impérativement observer la section « Élimination des déchets », point 1.

5. Selon les fonctions, certains produits, tels que des systèmes de radiocommunication RF, peuvent produire des niveaux élevés de rayonnement électromagnétique. Étant donné la vulnérabilité de l'enfant à naître, les femmes enceintes doivent être protégées par des mesures appropriées. Les porteurs de stimulateurs cardiaques peuvent également être menacés par les rayonnements électromagnétiques. L'employeur/l'exploitant est tenu d'évaluer et de repérer les lieux de travail soumis à un risque particulier d'exposition aux rayonnements et de prévenir les dangers éventuels.
6. En cas d'incendie, il se peut que le produit dégage des matières toxiques (gaz, liquides, etc.) susceptibles de nuire à la santé. Il faut donc, en cas d'incendie, prendre des mesures adéquates comme par exemple le port de masques respiratoires et de vêtements de protection.
7. Si un produit laser est intégré dans un produit Rohde & Schwarz (par exemple lecteur CD/DVD), il ne faut pas utiliser de réglages ou fonctions autres que ceux décrits dans la documentation produit pour éviter tout dommage corporel (par exemple causé par rayon laser).
8. Classes CEM (selon EN 55011 / CISPR 11 ; selon EN 55022 / CISPR 22, EN 55032 / CISPR 32 par analogie)
   - Appareil de la classe A :
     Appareil approprié à un usage dans tous les environnements autres que l'environnement résidentiel et les environnements raccordés directement à un réseau d'alimentation basse tension qui alimente des bâtiments résidentiels.
     Remarque : ces appareils peuvent provoquer des perturbations radioélectriques dans l'environnement résidentiel en raison de perturbations conduites ou rayonnées. Dans ce cas, on peut exiger que l'exploitant mette en œuvre de mesures appropriées pour éliminer ces perturbations.
   - Appareil de la classe B :
     Appareil approprié à un usage dans l'environnement résidentiel ainsi que dans les environnements raccordés directement à un réseau d'alimentation basse tension qui alimente des bâtiments résidentiels.

Réparation et service après-vente

1. Le produit ne doit être ouvert que par un personnel qualifié et autorisé. Avant de travailler sur le produit ou de l'ouvrir, il faut le couper de la tension d'alimentation ; sinon il y a risque de choc électrique.
2. Les travaux d'ajustement, le remplacement des pièces, la maintenance et la réparation ne doivent être effectués que par des électroniciens qualifiés et autorisés par Rohde & Schwarz. En cas de remplacement de pièces concernant la sécurité (notamment interrupteur d'alimentation, transformateur d'alimentation réseau ou fusibles), celles-ci ne doivent être remplacées que par des pièces d'origine. Après chaque remplacement de pièces concernant la sécurité, une vérification de sécurité doit être effectuée (contrôle visuel, vérification du conducteur de protection, mesure de la résistance d'isolement et du courant de fuite, essai de fonctionnement). Cela permet d'assurer le maintien de la sécurité du produit.

Batteries et accumulateurs/cellules

Si les instructions concernant les batteries et accumulateurs/cellules ne sont pas ou sont insuffisamment respectées, cela peut provoquer des explosions, des incendies et/ou des blessures graves pouvant entraîner la mort. La manipulation de batteries et accumulateurs contenant des électrolytes alcalins (par exemple cellules de lithium) doit être conforme à la norme EN 62133.

1. Les cellules ne doivent être ni démontées, ni ouvertes, ni réduites en morceaux.
2. Ne jamais exposer les cellules ou batteries à la chaleur ou au feu. Ne pas les stocker dans un endroit où elles sont exposées au rayonnement direct du soleil. Tenir les cellules et batteries au sec. Nettoyer les raccords sales avec un chiffon sec et propre.
3. Ne jamais court-circuiter les cellules ou batteries. Les cellules ou batteries ne doivent pas être gardées dans une boîte ou un tiroir où elles peuvent se court-circuiter mutuellement ou être court-circuitées par d'autres matériaux conducteurs. Une cellule ou batterie ne doit être retirée de son emballage d'origine que lorsqu'on l'utilise.
4. Les cellules ou batteries ne doivent pas être exposées à des chocs mécaniques de force non admissible.
5. En cas de manque d'étanchéité d'une cellule, le liquide ne doit pas entrer en contact avec la peau ou les yeux. S'il y a contact, rincer abondamment à l'eau l'endroit concerné et consulter un médecin.
6. Il y a danger d'explosion en cas de remplacement ou chargement incorrect des cellules ou batteries qui contiennent des électrolytes alcalins (par exemple cellules de lithium). Remplacer les cellules ou batteries uniquement par le type Rohde & Schwarz correspondant (voir la liste des pièces de rechange) pour maintenir la sécurité du produit.
7. Il faut recycler les cellules ou batteries et il est interdit de les éliminer comme déchets normaux. Les accumulateurs ou batteries qui contiennent du plomb, du mercure ou du cadmium sont des déchets spéciaux. Observer les règles nationales d'élimination et de recyclage.

Transport

1. Le produit peut avoir un poids élevé. Il faut donc le déplacer ou le transporter avec précaution et en utilisant le cas échéant un moyen de levage approprié (par exemple, chariot élévateur) pour éviter des dommages au dos ou des blessures.
2. Les poignées des produits sont une aide de manipulation exclusivement réservée au transport du produit par des personnes. Il est donc proscrit d'utiliser ces poignées pour attacher le produit à ou sur des moyens de transport, tels que grues, chariots et chariots élévateurs, etc. Vous êtes responsable de la fixation sûre des produits à ou sur des moyens de transport et de levage appropriés. Observer les consignes de sécurité du fabricant des moyens de transport ou de levage utilisés pour éviter des dommages corporels et des dégâts sur le produit.
3. L'utilisation du produit dans un véhicule se fait sous l'unique responsabilité du conducteur qui doit piloter le véhicule de manière sûre et appropriée. Le fabricant décline toute responsabilité en cas d'accidents ou de collisions. Ne jamais utiliser le produit dans un véhicule en mouvement si cela pouvait détourner l'attention du conducteur. Sécuriser suffisamment le produit dans le véhicule pour empêcher des blessures ou dommages de tout type en cas d'accident.

Élimination des déchets

1. Au terme de leur durée de vie, les batteries ou accumulateurs qui ne peuvent pas être éliminés avec les déchets ménagers peuvent uniquement être éliminés par des points de collecte appropriés ou par un centre de service après-vente Rohde & Schwarz.

2. Au terme de sa durée de vie, un produit ne peut pas être éliminé avec les déchets ménagers normaux, mais doit être collecté séparément.
   Rohde & Schwarz GmbH & Co. KG a développé un concept d'élimination des déchets et assume toutes les obligations en matière de reprise et d'élimination, valables pour les fabricants au sein de l'UE. Veuillez vous adresser à votre centre de service après-vente Rohde & Schwarz pour éliminer le produit de manière écologique.
3. Si les produits ou leurs composants sont travaillés mécaniquement et/ou thermiquement au-delà de l'utilisation prévue, ils peuvent, le cas échéant, libérer des substances dangereuses (poussières contenant des métaux lourds comme par exemple du plomb, du béryllium ou du nickel). Le démontage du produit ne doit donc être effectué que par un personnel qualifié et spécialement formé. Le démontage inadéquat peut nuire à la santé. Les règles nationales concernant l'élimination des déchets doivent être observées.
4. Si, lors de l'utilisation du produit, des substances dangereuses ou combustibles exigeant une élimination spéciale sont dégagées, comme par exemple liquides de refroidissement ou huiles moteurs qui sont à changer régulièrement, les consignes de sécurité du fabricant de ces substances dangereuses ou combustibles ainsi que les règles sur l'élimination en vigueur au niveau régional doivent être respectées. Les consignes de sécurité spéciales correspondantes dans la documentation produit doivent également être respectées, le cas échéant. L'élimination non conforme des substances dangereuses ou combustibles peut provoquer des atteintes à la santé et des dommages écologiques.

Pour plus d'informations concernant la protection de l'environnement, voir la page d'accueil de Rohde & Schwarz.

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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Contents

1 Preface

1.1 About This Manual

The main focus in this manual is on the measurement results and the different solutions provided to configure and obtain them. The following topics are included:

- **Welcome to the R&S NRPxxS[N]**
  Introduction to and getting familiar with the power sensors
- **Getting Started**
  Information that you have received as a printed book together with your instrument
- **The WebGui**
  Description of the functionalities of the WebGui
- **R&S NRP Toolkit Program Modules**
  Description on handling S-Parameters Tool and updating the firmware
- **Remote Commands**
  Remote commands required to configure and perform measurements in a remote environment
- **Appendix**
  Extensive reference information on remote control
- **List of Commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

You can find additional information about the usage of the R&S NRPxxS[N] power sensors on the Rohde & Schwarz website and on the delivered documentation CD.

The user documentation delivered with the R&S NRPxxS[N] power sensors consists of the following parts:

- Printed Getting Started
- Documentation CD-ROM with:
  - Getting Started
  - User Manual
  - Data sheet and product brochure
  - A selection of related application notes
  - Links to useful sites on the Rohde & Schwarz website

Getting Started

This manual is delivered with the R&S NRPxxS[N] power sensors in printed form and in PDF format on the documentation CD-ROM. It provides the information required to

start working with the power sensors. Basic operation and typical setup examples are described.

User Manual

The user manual is available in PDF format on the documentation CD-ROM delivered with the power sensors. In these manuals, all power sensor type specific functions are described in detail. Furthermore, it provides an introduction to remote control and a complete description of the remote control commands.

Internet

On the Rohde & Schwarz website you can find all available documentation for your R&S NRPxxS[N] power sensor. Additionally, there are several application notes available. You can also download the latest version of the available firmware and software.

1.3 Typographical Conventions

The following text markers are used throughout this documentation:

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

2 Welcome to the R&S NRPxxS[N]

The 3-path diode power sensors R&S NRPxxS and R&S NRPxxSN LAN power sensors are the first members of a series of new RF power sensors from Rohde & Schwarz. All sensors provide a USB high-speed interface which constitutes both the communication port and the power supply connection. Additionally, the R&S NRPxxSN LAN power sensors, the so called network sensors, are equipped with a Gigabit Ethernet interface with Power-over-Ethernet (PoE) power supply.

The R&S NRP33SN-V power sensor is optimized for the usage in a vaccuum chamber allowing measurements under special conditions.

The new power sensors are compatible in both the interface (USB) and a common command subset with the R&S NRP-Zxx power sensors. This enables the easy replacement of a new and an old power sensors.

This user manual contains a description of the provided functionality, including remote control operation. The latest version is available for download at the product homepage.

3 Getting Started

This section contains the information you have received as a printed book together with your instrument. The information is provided again to enable you to search throughout the complete description. If you are already familiar with the described topics, proceed to the next chapter.

3.1 Preparing for Use

This section describes the basic steps to be taken when setting up the R&S NRPxxS[N] power sensors for the first time.

NOTICE

Risk of instrument damage

Note that the following instructions and the general safety instructions contain information on operating conditions that prevent damage to the instrument. The instrument's data sheet may contain additional operating conditions.

NOTICE

Risk of electrostatic discharge

Protect the work area against electrostatic discharge to avoid damage to electronic components in the modules. For details, refer to the general safety instructions.

NOTICE

Risk of instrument damage during operation

An unsuitable operating site or test setup can cause damage to the power sensor and to connected devices. Ensure the following operating conditions:

- The power sensor is dry and shows no sign of condensation.
- The power sensor is connected as described in the following sections.
- The ambient temperature does not exceed the permissible temperature range specified in the data sheet.
- Signal levels at the input connectors are all within the specified ranges.
- Signal outputs are correctly connected and are not overloaded.

NOTICE

Risk of contamination of the R&S NRP33SN-V power sensor

Always wear clean protective gloves when handling the R&S NRP33SN-V vacuum power sensors to protect the device and its environment from contamination.

NOTICE

Recommended bake-out procedure for R&S NRP33SN-V power sensor

When the sensor is inserted in a vacuum chamber, vacuum baking for 100 hours at 85°C and a pressure lower than 10^{-5} mbar should be performed.

3.1.1 EMI Suppression

Electromagnetic interference (EMI) may affect the measurement results.

To suppress generated electromagnetic interference:

- Use suitable shielded cables of high quality. For example, use double-shielded RF cables.
- Always terminate open cable ends.
- Note the EMC classification in the data sheet.

3.1.2 Unpacking and Checking the Instrument

Check the equipment for completeness using the delivery note and the accessory lists for the various items. Check the power sensor for any damage. If there is damage, immediately contact the carrier who delivered the instrument. Make sure not to discard the box and packing material.

Packing material and transportation

Always make sure that sufficient mechanical and electrostatic protection is provided when transporting the power sensors.

3.1.3 R&S NRPxxS[N] Power Sensors Tour

This chapter provides an overview of the available connectors and LEDs of the R&S NRPxxS[N] power sensors.

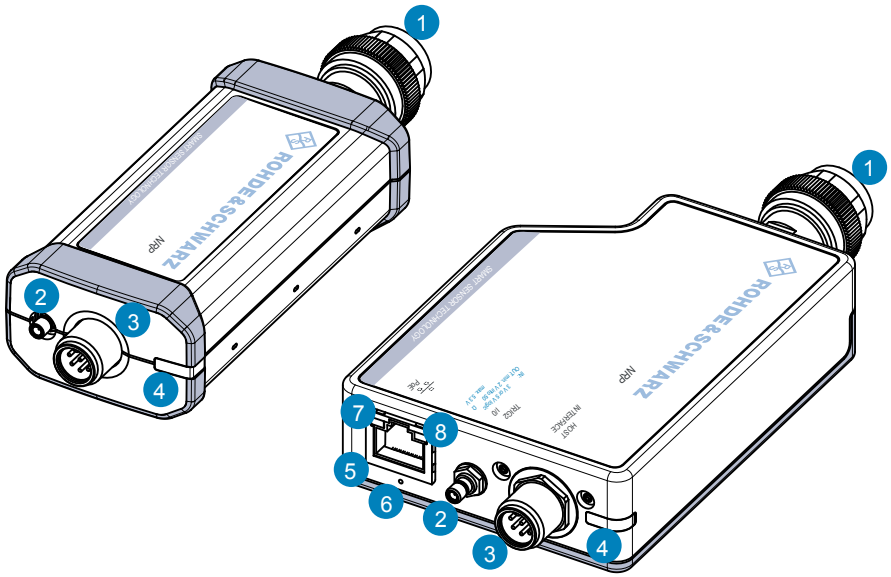


Figure 3-1: The R&S NRP power sensors

1 = RF connector
2 = Trigger I/O connector
3 = Host Interface connector
4 = Status LED
5 = LAN connector
6 = LAN Reset button
7 = Power over Ethernet status LED
8 = Network status LED

RF Connector

The RF connector of the power sensors is used for connecting them to a Device Under Test (DUT) or a signal generator.

For maximum measurement accuracy, the RF connector must be tightened using a torque wrench with a specific nominal torque. The required nominal torque as well as the type of connector that the sensors have are shown in the following table.

Table 3-1: RF connectors of the power sensors

Power sensor	Male connector	Matching female connector	Tightening torque
R&S NRP8S	N	N	1.36 Nm (12" lbs)
R&S NRP8SN			
R&S NRP18S			
R&S NRP18SN			
R&S NRP33S	3.50 mm	3.50 mm/ 2.92 mm/ SMA	0.90 Nm (8" lbs)
R&S NRP33SN			
R&S NRP33SN-V			

Power sensor	Male connector	Matching female connector	Tightening torque
R&S NRP40S	2.92 mm	3.50 mm/ 2.92 mm/ SMA	
R&S NRP40SN			
R&S NRP50S	2.4 mm	2.4 mm/ 1.85 mm	
R&S NRP50SN			

Trigger I/O connector

The Trigger I/O is a connector of SMB type. A BNC-to-SMB trigger cable is within the scope of delivery.

It is used as an input for signals if the trigger source parameter is set to `EXTernal2`. It is used as an output for trigger signals if the sensor is operated in the trigger master mode. For more details, see the user manual.

Host Interface

The Host Interface connector is used for establishing a connection between the power sensors and a USB host or a supported Rohde & Schwarz instrument. For this purpose an external cable is needed. Two types of cables are available:

- An NRP-ZKU cable with a USB connector, for connecting the power sensor to a USB host device (R&S order number 1419.0658.xx)
- An NRP-ZK6 cable with a push-pull type connector, for connecting the power sensor to the R&S NRP2 or other Rohde & Schwarz products with the round connector (R&S order number 1419.0664.xx)

These cables can be obtained in different lengths up to 5 meters.

Status LED

The Status LED gives information about the state of the power sensor. The following states are defined:

Color	State
White	Idle state. The sensor performs no measurement and is ready for use.
Blinking white	Firmware update is in progress
Yellow	Wait for trigger state
Green	Measuring state
Turquoise blue	Zeroing is in progress
Slow blinking red	A static error. You can query the type of the error with `SYSTem:SERRor?`
Fast blinking red	A critical static error. You can query the type of the error with `SYSTem:SERRor?` **Hint:** If this happens after a firmware update, the update was not successful. Please perform the firmware update again.

LAN

Available only for the R&S NRPxxSN LAN power sensors.

An RJ-45 connector is used to connect the Ethernet interface of the power sensors to a Local Area Network (LAN).

Ethernet interface requires PoE (Power-over-Ethernet)

When using the Ethernet interface of the power sensors, the electrical power has to be provided by means of Power over Ethernet (PoE). In this case, it is **not** possible to provide the power supply via the USB connector instead.

NOTICE

Risk of instrument damage

Use only PoE power sourcing equipment (PSE) according to IEEE standards 802.3af or IEEE 802.3at.

Otherwise your power sensor may get damaged.

LAN Reset Button

The LAN Reset button is used for resetting the Ethernet connection parameters of the power sensor to their default values.

Power over Ethernet Status LED

Available only for the R&S NRPxxSN LAN power sensors.

The power status LED shows whether the sensor is correctly powered over PoE or not.

- **Green** indicates that the sensor is powered over PoE and can be operated via the Ethernet interface.
- **No light** indicates that PoE power is not present.

Network Status LED

Available only for the R&S NRPxxSN LAN power sensors.

The network status LED shows whether the LAN connection to the network is established properly or not.

- **Green** indicates that the power sensor is correctly connected to the network and has been assigned a valid IP address, either manually or via DHCP.
- **Red** indicates that there is either an erroneous connection or the sensor has not been assigned a valid IP address.

3.1.4 Connecting the R&S NRPxxS[N] Power Sensors

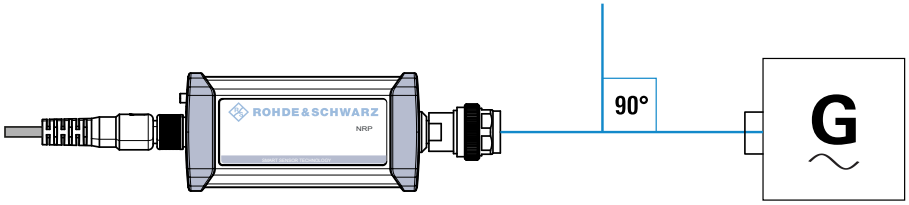
Connecting the RF connector of the R&S NRPxxS[N] power sensors

NOTICE

Risk of damage to the center pin of the RF connector

When connecting the power sensor always rotate only the hex nut of the RF connector. Do not rotate the sensor itself because this may damage the center pin of the connector.

1. Ensure that the RF connector of your DUT is compatible with the RF connector of the power sensors.
   Refer to Table 3-1 to find out what kind of RF connector your sensor has and the recommended nominal torque.
2. Keep the RF connector perpendicular and insert it into the RF output of your DUT.



3. Loosely tighten the RF connector manually.
4. To ensure maximum measurement accuracy, tighten the RF connector using a torque wrench with the recommended nominal torque.

Connecting a cable to the host interface of the R&S NRPxxS[N] power sensors

To connect a NRP-ZKU or a NRP-ZK6 to the power sensor:

1. Insert the screw-lock cable connector into the Host Interface connector of the power sensor.
2. Tighten the union nut manually.

3.1.5 Disconnecting the R&S NRPxxS[N] Power Sensors

Disconnecting the RF connector of the R&S NRPxxS[N] power sensors

NOTICE

Risk of damage to the center pin of the RF connector

When disconnecting the power sensor always rotate only the hex nut of the RF connector. Do not rotate the sensor itself because this may damage the center pin of the connector.

► Carefully loosen the union nut at the front of the RF connector of the sensor and then remove the sensor.

Disconnecting the host interface of the R&S NRPxxS[N] power sensors

► Loosen the union nut of the screw-lock cable connector and remove the cable.

3.2 Setting Up a Connection to a PC

There are different possibilities for connecting a power sensor to a PC, which may differ depending on the type of power sensor and available accessories.

The following chapter gives an overview of the possible setups and what equipment is needed for each of them.

3.2.1 Setting Up a Simple USB Connection

All R&S NRPxxS[N] power sensors can be connected to a PC by means of a USB interface and controlled by a supported software or a remote program.

Required equipment:

- An R&S NRPxxS[N] power sensor
- A NRP-ZKU cable

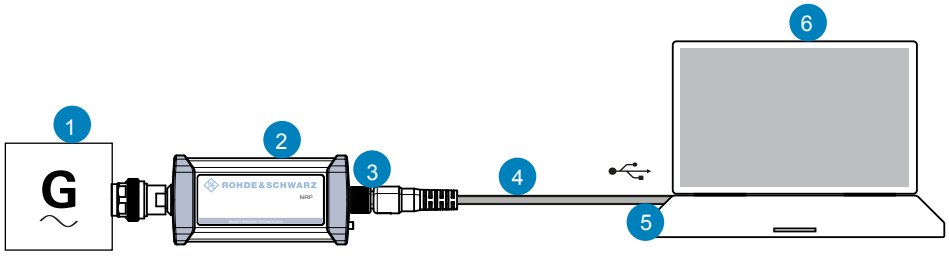


Figure 3-2: Configuration with a NRP-ZKU

1 = Signal source
2 = R&S NRPxxS[N] power sensor
3 = Host Interface connector
4 = NRP-ZKU cable
5 = USB connector
6 = PC with installed VISA driver or R&S NRP Toolkit

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the cables as shown in Figure 3-2 :
   a) Connect the NRP-ZKU cable to the power sensor.
   b) Connect the NRP-ZKU cable to the computer.
   c) Connect the power sensor to the signal source.
2. On the computer, start a software application to view the measurement results.

3.2.2 Setting Up a Connection Using a R&S NRP-Z5 Sensor Hub

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

Required equipment:

- 1 to 4 R&S NRPxxS[N] power sensors
- 1 NRP-ZK6 cable per sensor
- A R&S NRP-Z5 sensor hub with external power supply unit and USB cable
- BNC cables to connect the trigger input and trigger output signals (optional)

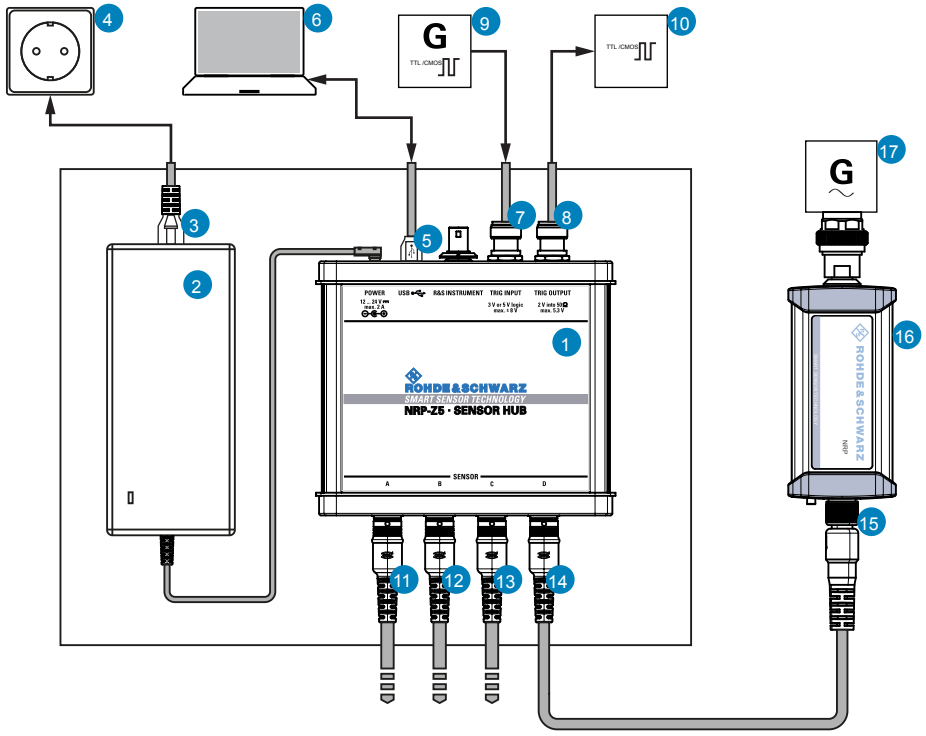


Figure 3-3: Configuration with an R&S NRP-Z5 sensor hub

1 = R&S NRP-Z5 sensor hub
2 = External power supply unit (supplied)
3 = Power cable (supplied)
4 = AC power supply
5 = USB cable (supplied)
6 = PC with USB host interface
7,8 = BNC cable (optional, not supplied)
9 = Trigger source (optional)
10 = Triggered device (optional)
11-14 = R&S NRP-ZK6 cable
15 = Host Interface connector
16 = R&S NRPxxS[N] power sensor
17 = Signal source

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the cables as shown in Figure 3-3:
   a) Connect the NRP-ZK6 cable to the power sensor.
   b) Connect the power sensors to the R&S NRP-Z5 sensor hub. You can connect up to four sensors.
   c) Connect the R&S NRP-Z5 to the computer.

d) Connect the power sensors to the signal source.
e) Connect the delivered external power supply unit to the R&S NRP-Z5 and to an AC supply connector.
f) Connect the trigger input of the R&S NRP-Z5 with a BNC cable to the trigger source (optional).
g) Connect the trigger output of the R&S NRP-Z5 with a BNC cable to the trigger device (optional).

2. On the computer, start a software application to view the measurement results.

3.2.3 Setting Up a Network (LAN) Connection with the R&S NRP LAN Power Sensors

This section describes how to connect the sensor to a LAN network and configure the LAN interface for establishing a connection.

3.2.3.1 Connecting a Network Sensor and a PC

There are different ways to connect the network power sensor to a PC according to the available equipment:

Using a PoE Ethernet switch

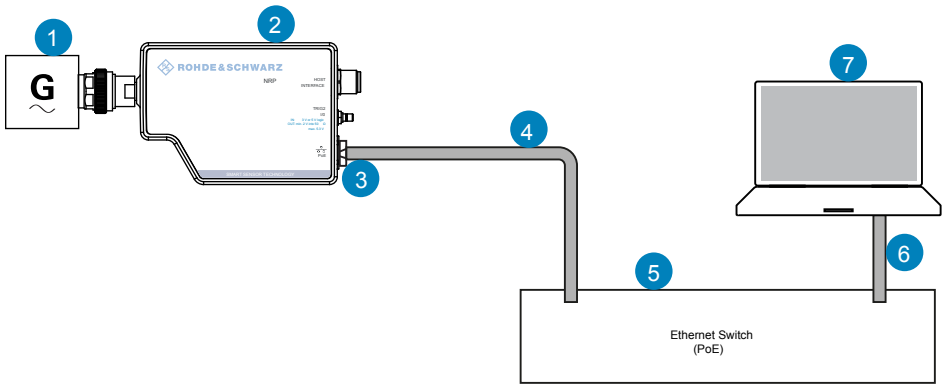


Figure 3-4: Configuration with a PoE Ethernet switch

1 = Signal source
2 = R&S NRPxxSN LAN power sensor
3 = RJ-45 Ethernet connector
4, 6 = RJ-45 Ethernet cable
5 = Ethernet switch supporting PoE power delivery, e.g. R&S NRP-ZAP1
7 = PC

1. Connect the RF connector of the sensor to the DUT.
2. Connect the RJ-45 Ethernet connector of the sensor to an Ethernet switch that supports PoE power delivery.

Notice: Use only PoE power sourcing equipment (PSE) according to IEEE 802.3af or IEEE 802.3at. Otherwise your power sensor may get damaged.

3. Connect the PC to the Ethernet switch.
4. Establish a connection between the power sensor and the network, see Chapter 3.2.3.2, "Establishing a Connection to the Network", on page 21.

Using a PoE injector and a Non-PoE Ethernet switch

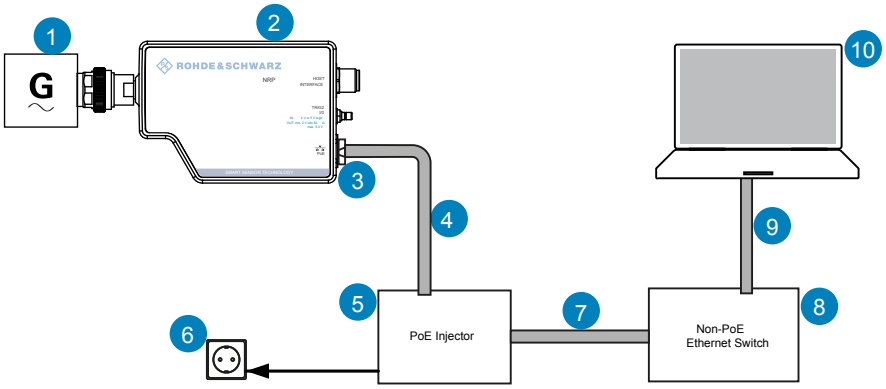


Figure 3-5: Configuration with a PoE injector and a Non-PoE Ethernet switch

1 = Signal source
2 = R&S NRPxxSN LAN power sensor
3 = RJ-45 Ethernet connector
4, 7,9 = RJ-45 Ethernet cable
5 = PoE injector
6 = AC supply
8 = Non-PoE Ethernet switch
10 = PC

1. Connect the RF connector of the sensor to the DUT.
2. Connect the RJ-45 Ethernet connector of the sensor to the output of the PoE injector.
   Notice: Use only PoE power sourcing equipment (PSE) according to IEEE 802.3af or IEEE 802.3at. Otherwise your power sensor may get damaged.
3. Connect the PoE injector to a power supply.
4. Connect the input of the PoE injector to the Non-PoE Ethernet switch.
5. Connect the PC to the Non-PoE Ethernet switch.
6. Establish a connection between the power sensor and the network, see Chapter 3.2.3.2, "Establishing a Connection to the Network", on page 21.

Using a PoE injector

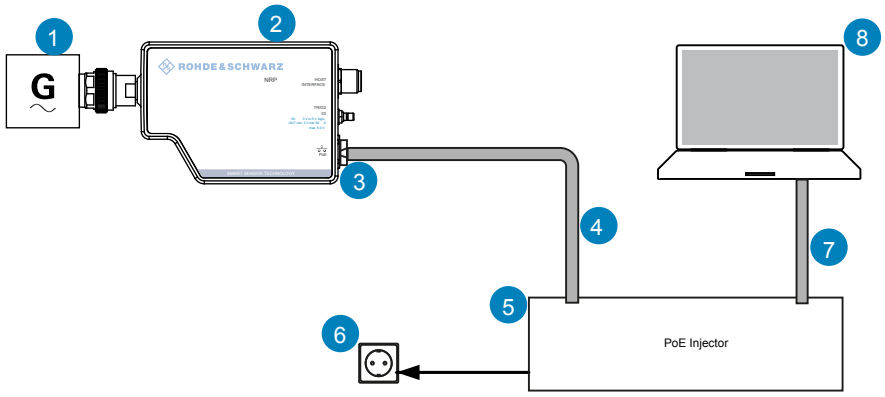


Figure 3-6: Configuration with a PoE injector

1 = Signal source
2 = R&S NRPxxSN LAN power sensor
3 = RJ-45 Ethernet connector
4, 7 = RJ-45 Ethernet cable
5 = PoE injector
6 = AC supply
8 = PC

1. Connect the RF connector of the sensor to the DUT.
2. Connect the RJ-45 Ethernet connector of the sensor to the output of the PoE injector.
   Notice: Use only PoE power sourcing equipment (PSE) according to IEEE 802.3af or IEEE 802.3at. Otherwise your power sensor may get damaged.
3. Connect the PoE injector to a power supply.
4. Connect the PC to the input of the PoE injector.
5. Establish a network connection between the power sensor and the PC.

3.2.3.2 Establishing a Connection to the Network

There are two methods to establish a network connection to a network power sensor:

- A non-dedicated network (Ethernet) connection from the sensor to an existing network
- A dedicated network connection (Point-to-point connection) between the LAN sensor and a single computer

In both cases, the host name can be used (see Chapter 3.2.3.4, "Using Hostnames", on page 22) or an IP address that has to be assigned to the LAN sensor and the computer, see Chapter 3.2.3.3, "Assigning the IP Address", on page 22.

To set up a network Ethernet connection

► Connect the power sensor to the network or to a single PC.

By default, the sensor is configured to use dynamic TCP/IP configuration and to obtain the address information automatically.

3.2.3.3 Assigning the IP Address

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

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), the address information can be assigned automatically.
- If the network does not support DHCP, the network power sensor tries to obtain the IP address via the Zeroconf (APIA) protocol. If this attempt does not succeed or if the instrument is set to use alternate TCP/IP configuration, the IP address must be set manually.
  For a description on how to set the IP address manually, refer to the user manual.

Use hostnames to identify the instrument

In networks using a DHCP server, it is recommended that you address the instrument by its unambiguous hostnames, see Chapter 3.2.3.4, "Using Hostnames", on page 22.

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

3.2.3.4 Using Hostnames

In a LAN that uses a Domain Name System (DNS) server, each PC or instrument connected in the LAN can be accessed via an unambiguous hostname instead of an IP address. The DNS server translates the hostname to the IP address. This is especially useful when a DHCP server is used, as a new IP address may be assigned each time the instrument is restarted.

Each power sensor is delivered with an assigned hostname that can be changed by the user.

The default hostname follows the syntax:

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

- `<device name>` is the short name of your sensor.
  For example, the `<device name>` of R&S NRP18SN is `nrp18sn`.
- `<serial number>` is the individual serial number of the power sensor. The serial number can be found ar the rear side of the sensor. It is the third part of the device ID printed on the bar code sticker Figure 3-7.

Figure 3-7: Serial number of the R&S NRPxxSN LAN power sensors

Example:

The default hostname of an R&S NRP18SN with a serial number 101441 will be `nrp18sn-101441`.

Networks without DHCP Server

In a network without DHCP server, the connected devices can obtain their IP addresses via a so-called Zeroconf method. The R&S network power sensors all support Zeroconf address allocation. In order to make this work properly, hostnames from the so-called link-local top level domains shall be used. This is accomplished by appending *.local* to the hostname.

For example, if used in conjunction with Zeroconf, a power sensor with a specified hostname of

`nrp18sn-101441`

should be referred to as

`nrp18sn-101441.local`

3.3 Using the Power Sensors with the R&S NRP Toolkit

The R&S NRP Toolkit is a software offered by Rohde & Schwarz that provides different possibilities for viewing and setting measurements performed with the R&S NRPxxS[N] power sensors. It contains the following modules:

- USB driver (obligatory)
- NrpControl2.dll dynamic link library (obligatory)
- S-Parameter tool
- R&S NRP-Z uncertainty calculator and its PDF manual
- R&S Power Viewer Plus and its PDF manual
- VxI plug&play with programming examples (optional, for installtaion enable "NRP-Toolkit-SDK" during the installation of the R&S NRP Toolkit)
- Firmware Update (Pure FW)

3.3.1 System requirements

Hardware requirements

The following hardware requirements must be fulfilled:

- Desktop PC or laptop
- Keyboard and optionally mouse
- USB interface
- NRP-ZKU cable or R&S NRP-Z5 sensor hub and a NRP-ZK6 cable

Supported operating systems

You can install the R&S NRP Toolkit on the following operating systems:

- Microsoft Windows Vista 32/64-Bit
- Microsoft Windows 7 32/64-Bit
- Microsoft Windows 8/ 8.1 32/64-Bit
- Microsoft Windows 10 32/64-Bit

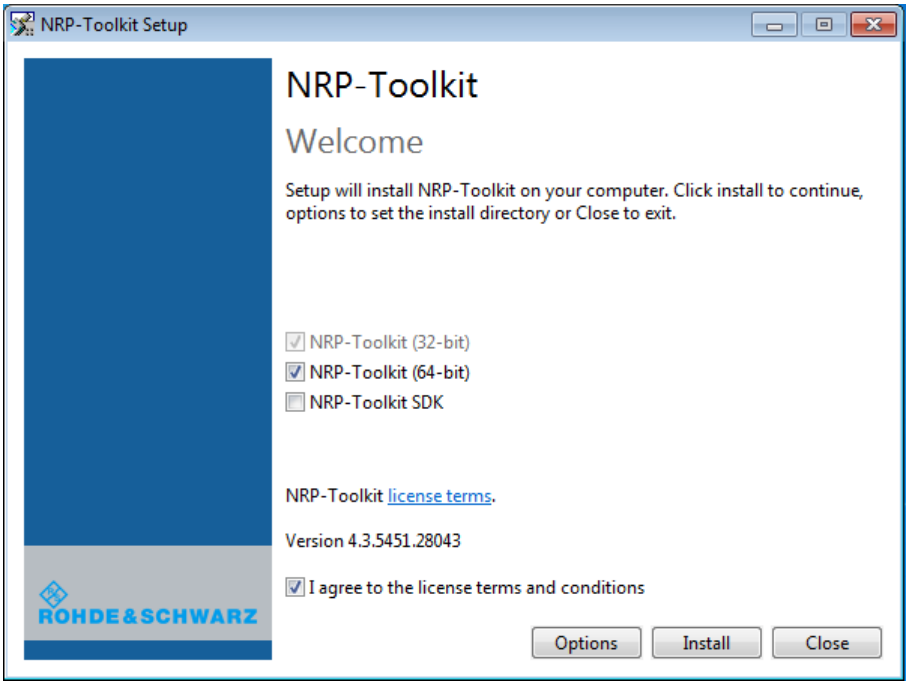
R&S NRP Toolkit versions for Linux distributions and MacOSX are also available on request. To obtain an R&S NRP Toolkit for an operating system other than Microsoft Windows contact the Rohde & Schwarz customer support:

customersupport@rohde-schwarz.com.

3.3.2 Installing the R&S NRP Toolkit on a Windows PC

To install the R&S NRP Toolkit

1. Start the R&S NRP Toolkit installer.
2. In the "Choose Components" window, select the components you want to install and accept the license terms in order to continue with the installation



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

3.3.3 Performing a Firmware Update

Use the Firmware Update program (PureFW) to load new firmware for the power sensors. It is part of the R&S NRP Toolkit that is supplied on a CD-ROM together with the power sensors.

For a description on how to do that refer to Chapter 5.2, " Firmware Update", on page 66.

3.4 Using the Power Sensors with the R&S NRPV

With the R&S NRPV you can perform power measurements in all available measurement modes. Additionally, you can use up to four power sensors simultaneously.

Required equipment:

- An R&S NRPxxS[N] power sensor
- A NRP-ZKU or an R&S NRP-Z5 sensor hub and a NRP-ZK6 cable to connect the sensor to the computer
- A Windows PC with installed:
  - R&S NRP Toolkit version V 4.3 or higher
  - R&S NRPV version 1.6.5 or higher (refer to the operating manual of the R&S NRPV for a description of the installation process)

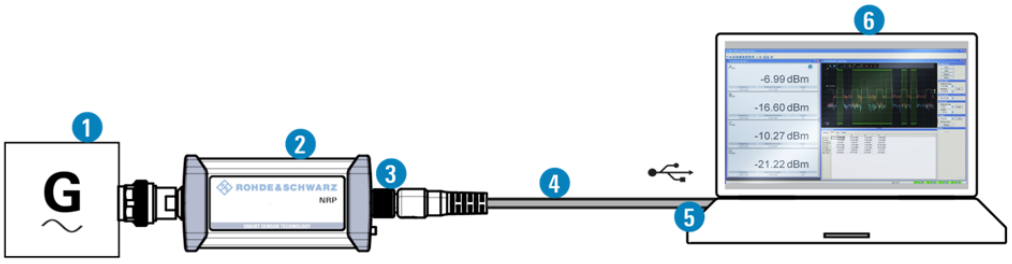


Figure 3-8: Configuration with an R&S NRPV

1 = Signal source
2 = R&S NRPxxS[N] power sensor
3 = Host Interface connector
4 = NRP-ZKU cable
5 = USB connector
6 = PC with installed R&S NRPV

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the power sensor to the PC as shown in Figure 3-8.
   For a detailed description, refer to Chapter 3.2.1, "Setting Up a Simple USB Connection", on page 16.
2. Start the R&S NRPV and execute zeroing:
   Note: Turn off all measurement signals before zeroing. An active measurement signal during zeroing causes an error.
   a) Switch off the measurement signal.
   b) Select "Zero > Select > A" (channel short name).

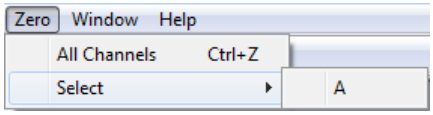


Figure 3-9: Zero channel

   Zeroing takes several seconds. While zeroing is executed a "Zeroing in progress..." message is displayed. When zeroing is completed, the message reports either success or an error (Success / Failed).
3. Switch on the test signal of the signal source.
4. To start a continuous measurement, select "Measure > Continuous".
   The "Continuous" measurement window appears. It shows the measurement results numerically, and the control panel for accessing further dialogs with parameters for measurement, evaluation and display.

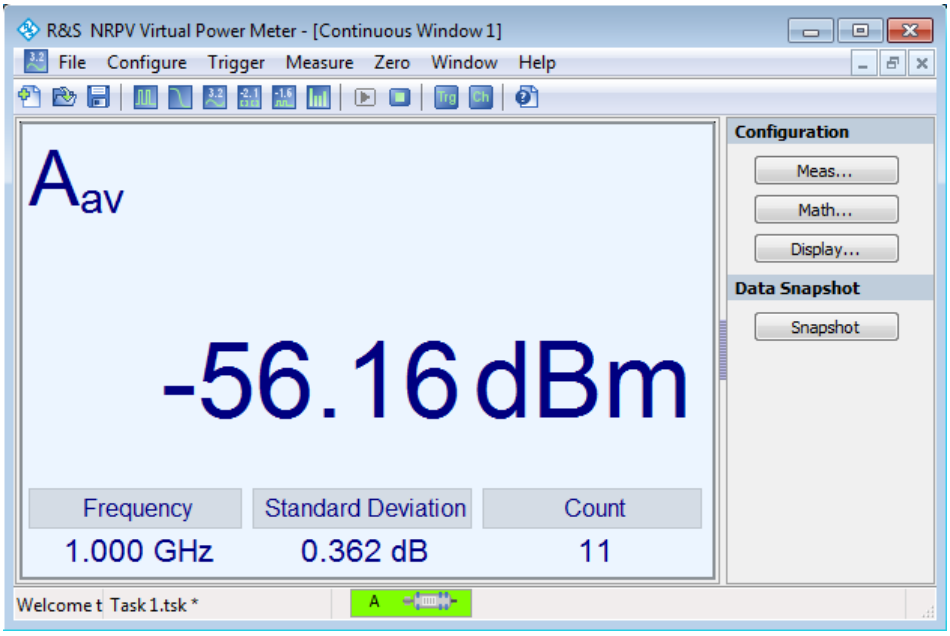


Figure 3-10: Continuous window

For a detailed description of how to perform different measurements in this setup, refer to the operating manual of your R&S NRPV.

3.5 Using the Sensors with the R&S Power Viewer Plus

The R&S Power Viewer Plus is a software that simplifies many measurement tasks. It is part of the R&S NRP Toolkit for Microsoft Windows and is also contained in some R&S NRP Toolkit for Linux and Mac OS X.

Required equipment:

- An R&S NRPxxS[N] power sensor
- A NRP-ZKU or an R&S NRP-Z5 sensor hub and a NRP-ZK6 cable to connect the sensor to the computer
- A PC with installed:
  - R&S NRP Toolkit version V 4.3 or higher
  - R&S Power Viewer Plus version 6.4 or higher (refer to the operating manual of the R&S Power Viewer Plus for a description of the installation process)

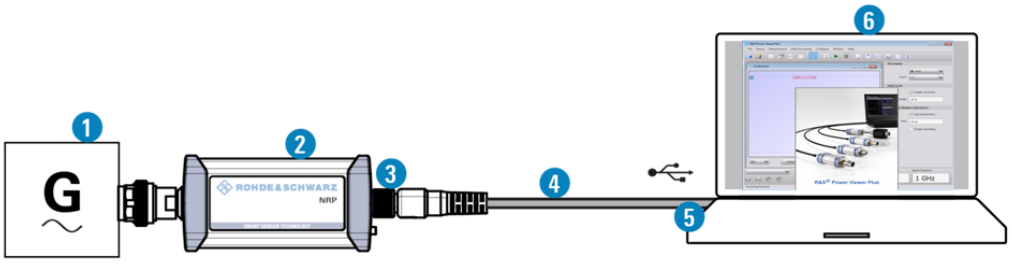


Figure 3-11: Configuration with the R&S Power Viewer Plus

1 = Signal source
2 = R&S NRPxxS[N] power sensor
3 = Host Interface connector
4 = NRP-ZKU cable
5 = USB connector
6 = PC with installed R&S Power Viewer Plus

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the cables as shown in Figure 3-11.
   For a detailed description, refer to Chapter 3.2.1, "Setting Up a Simple USB Connection", on page 16.
2. Start the R&S Power Viewer Plus and execute zeroing:
   Note: Turn off all measurement power signals before zeroing. An active measurement signal during zeroing causes an error.
   a) Switch off the measurement signal.
   b) Select "Sensor > Zero (Signal off) ".

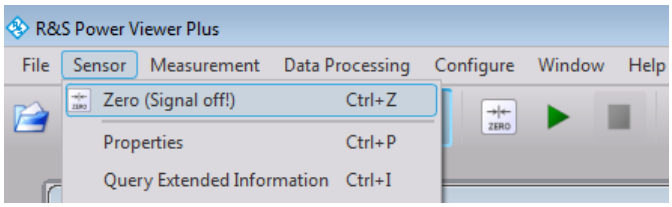
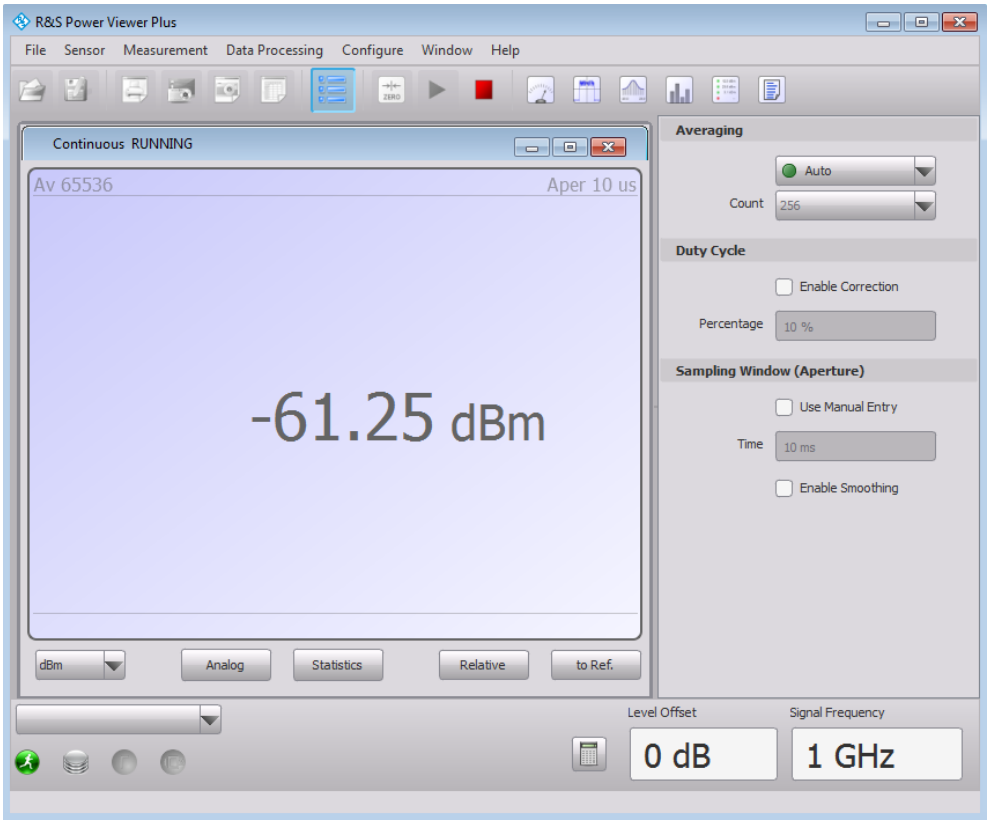


Figure 3-12: Zero channel

3. Switch on the test signal of the signal source.
4. For a continuous average measurement, select "Measurement > Continuous".
   The "Continuous" measurement window appears. It shows the measurement results numerically and some parameters that can be configured.
5. To start the measurement press "Measurement > Start".
   The measurement result is shown in the "Continuous" measurement window.



For a detailed description of how to perform different measurements in this setup, refer to the operating manual of your R&S Power Viewer Plus. The manual is installed automatically during the installation of the R&S Power Viewer Plus.

3.6 Using the WebGUI of the Network Sensors

With the integrated, browser based graphical user interface (WebGUI) of the R&S NRPxxSN LAN power sensors you can easily configure the most common settings and perform measurements in the provided measurement modes.

There is no installation required. The WebGUI can be used with all devices and operating systems, including tablets and smart phones that are connected to the same network.

Required equipment:

- An R&S NRPxxSN LAN power sensor
- LAN cables
- PoE Ethernet switch or a non-PoE Ethernet switch and a PoE injector
- A device with a supported web browser installed:
  - Mozilla Firefox 33 or later
  - Google Chrome 36 or later
  - Microsoft Internet Explorer 10 or later

– Safari 5.1 or later

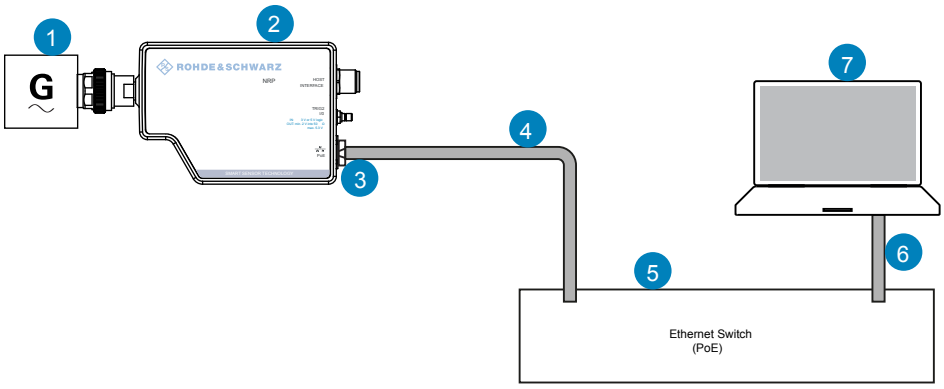


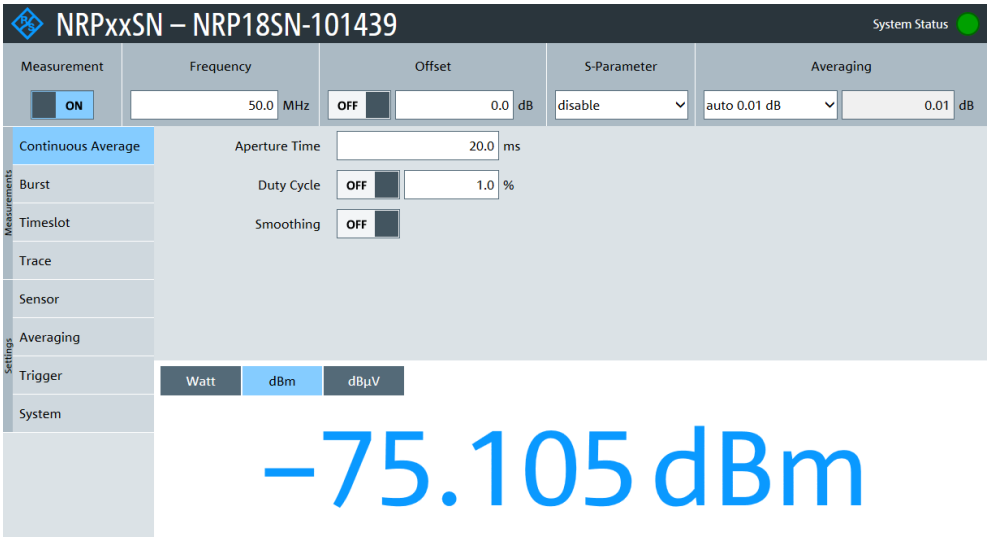
Figure 3-13: Configuration with the WebGUI

1 = Signal source
2 = R&S NRPxxSN LAN power sensor
3 = RJ-45 Ethernet connector
4, 6 = RJ-45 Ethernet cable
5 = Ethernet switch supporting PoE power delivery
7 = PC with a supported web browser installed

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the cables as shown in Figure 3-13.
   For a detailed description, refer to Chapter 3.2.3, "Setting Up a Network (LAN) Connection with the R&S NRP LAN Power Sensors", on page 19.
2. Open a supported web browser.
3. Enter the instrument name or the IP address of the sensor you want to connect to.
   For details on how to find out the IP address or hostname refer to Chapter 3.2.3.3, "Assigning the IP Address", on page 22 and Chapter 3.2.3.4, "Using Hostnames", on page 22.



The main panel of the WebGUI opens.

4. Select the "Continuous Average" tab and perform any necessary changes.
5. Press "Measurement > ON" to start the measurement.

For a detailed description of the WebGUI functions, refer to Chapter 4, "The WebGUI", on page 40.

3.7 Using the Power Sensors with an R&S NRP2

With the R&S NRPxxS[N] power sensors and an R&S NRP2 you can perform power measurements with up to four power sensors simultaneously. All sensor-dependent measurement functions can be used and the results can be displayed in parallel.

Required equipment:

- An R&S NRPxxS[N] power sensor
- An NRP-ZK6 to connect the sensor to the R&S NRP2
- An R&S NRP2 base unit with FW version 7.11 or higher

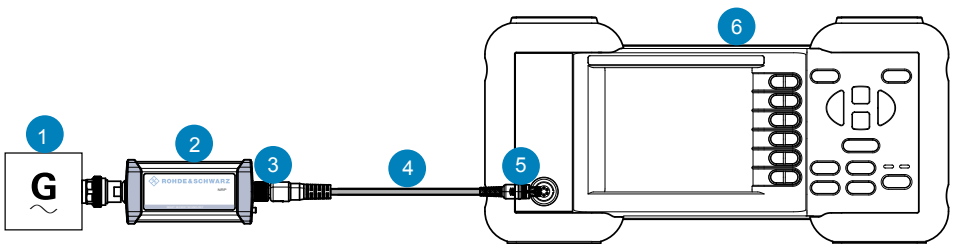


Figure 3-14: Configuration with an R&S NRP2 base unit

1 = Signal source
2 = R&S NRPxxS[N] power sensor
3 = Host Interface connector
4 = NRP-ZK6 cable
5 = Sensor input connector of the R&S NRP2
6 = R&S NRP2 base unit

Incorrectly connecting/disconnecting the R&S NRPxxS[N] power sensors may damage the power sensors or lead to erroneous results.

Ensure that you connect/disconnect your power sensors as described in Chapter 3.1.4, "Connecting the R&S NRPxxS[N] Power Sensors", on page 15.

1. Connect the cables as shown in Figure 3-14:
   a) Connect the NRP-ZK6 cable to the Host Interface connector of the sensor.
   b) Connect the NRP-ZK6 cable to a Sensor input connector of the R&S NRP2.
   c) Connect the RF connector of the power sensor to the signal source.
2. Preset the R&S NRP2.
   a) Press the (PRE)SET hardkey.
   The "File" menu appears.
   b) Press the (PRE)SET hardkey again or press the "Preset" softkey.
   All parameters are set to their defaults, also those of inactive operating modes.
3. Execute zeroing:
   Note: Turn off all measurement signals before zeroing. An active measurement signal during zeroing causes an error.
   a) Switch off the power of the signal source.
   b) Press the ZERO hardkey of the R&S NRP2.
   The "Zero" dialog box is displayed.

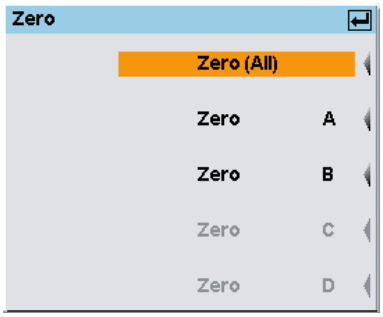


Figure 3-15: Zeroing dialog box

   c) Press the ZERO hardkey again to perform zeroing of all connected sensor channels ("Zero (All)") or press the appropriate softkey to select a specific sensor for zeroing.
4. Press the FREQ hardkey and enter the carrier frequency of the applied signal if the specified measurement accuracy is to be reached.
5. Switch on the signal source.

The result window indicates the result (in dBm) obtained with sensor A.

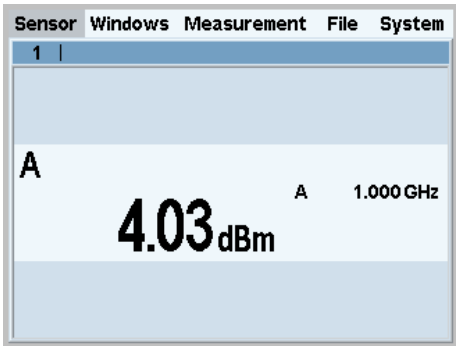


Figure 3-16: Result window (dBm)

6. If required, perform further settings.

For a detailed description of how to perform different measurements in this setup, refer to the operating manual of your R&S NRP2.

3.8 Remote Control Interfaces and Protocols

The R&S NRPxxS[N] power sensors can be remote controlled which enables their integration into custom automatic test equipment (ATE) systems. The latest version of the instrument drivers is available on the Rohde & Schwarz website as part of the downloadable NRP Toolkit.

The power sensors support different interfaces for remote control depending on the type of sensor. The R&S NRPxxS[N] USB power sensor are always connected to the controlling PC via USB, while R&S NRPxxSN LAN power sensors can be accessed via USB or Ethernet. The following protocols are supported for each interface:

Table 3-2: Remote control interfaces and protocols

Interface	Supported by	Protocols, VISA*) address string and Library
USB	All power sensors	• **USBTMC** `USB::<vendor ID>::<product ID>::<serial number>[::INSTR]` VISA • **NRP legacy protocol**

Ethernet	Network power sensors	• **VXI-11**
		`TCPIP::host address[::LAN device name][::INSTR]`
		VISA
		• **HiSLIP** High-Speed LAN Instrument Protocol (IVI-6.1)
		`TCPIP::host address::hislip0[::INSTR]`
		VISA
		• **Socket communication** (LAN Ethernet)
		`TCPIP::host address[::LAN device name]::<port>::SOCKET`

(*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control over LAN (when using VXI-11 or HiSLIP protocol) and USBTMC interfaces.		

3.8.1 USB Interface

For remote control using USB connection, the PC and the power sensors must be connected via the USB interface. A USB connection requires the VISA library to be installed. VISA detects and configures the R&S power sensors automatically when the USB connection is established. You do not have to enter an address string or install a separate driver.

USBTMC (USB Test & Measurement Class Specification) is a protocol that is built on top of USB for communication with USB devices. It defines class code information of the sensor, that identifies its functionality in order to load the respective device driver. Using VISA library, it supports service request, triggers and other operations that are commonly found in GPIB devices.

Besides USBTMC, the NRP legacy protocol is available to ensure the compatibility of the R&S NRPxxS[N] power sensors with the R&S NRP-Zxx series of power sensors. The usage of this protocol is not recommended for new applications.

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

USB Resource String

The syntax of the used USB resource string is:

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

where:

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

Table 3-3 gives an overview of the USB product IDs.

Table 3-3: USB Product IDs

R&S NRPxxS[N] power sensor	USB product ID
R&S NRP8S	0x00E2
R&S NRP8SN	0x0137
R&S NRP18S	0x0138
R&S NRP18SN	0x0139
R&S NRP33S	0x0145
R&S NRP33SN	0x0146
R&S NRP33SN-V	0x0168
R&S NRP40S	0x015F
R&S NRP40SN	0x0160

R&S NRPxxS[N] power sensor	USB product ID
R&S NRP50S	0x0161
R&S NRP50SN	0x0162

Example:

`USB::0x0AAD::0x00E2::100001`

0x0AAD is the vendor ID for Rohde & Schwarz

0x00E2 is the product ID for the R&S NRP8S power sensor

100001 is the serial number of the particular power sensor

3.8.2 Ethernet Interface

The Ethernet interface of the network power sensors allows to integrate them in a local area network (LAN).

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

3.8.2.1 VISA Resource Strings

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

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

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

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

You can also assign a **LAN device name** which defines the protocol characteristics of the connection. See the description of the VISA resource string below for the corresponding interface protocols. The highlighted characters are crucial.

HiSLIP

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

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

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

For details of the HiSLIP protocol, refer to Chapter 3.8.2.3, "HiSLIP Protocol", on page 37 .

VXI-11

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

- **[::inst0]** LAN device name, indicates that the VXI-11 protocol is used (optional)

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

For details of the VXI-11 protocol, refer to Chapter 3.8.2.2, "VXI-11 Protocol", on page 36 .

Socket Communication

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

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

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

The registered port for socket communication is port 5025.

For details of the socket communication, refer to Chapter 3.8.2.4, "Socket Communication", on page 37.

Example:

- A power sensor has the IP address *10.111.11.20*; the valid resource string using VXI-11 protocol is:
  `TCPIP::10.111.11.20::INSTR`
- The DNS host name is *nrp18sn-100001*; the valid resource string is:
  `TCPIP::nrp18sn-100001::hislip0` (HiSLIP)
  `TCPIP::nrp18sn-100001::inst0` (VXI-11)
- A raw socket connection can be established using:
  `TCPIP::10.111.11.20::5025::SOCKET`
  `TCPIP::nrp18sn-100001::5025::SOCKET`

3.8.2.2 VXI-11 Protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured.

TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

3.8.2.3 HiSLIP Protocol

The HiSLIP (**Hi**gh **S**peed **L**AN **I**nstrument **P**rotocol) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - the first for fast data transfer, the second one for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

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

For more information see also the application note at:

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

3.8.2.4 Socket Communication

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

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

3.9 Replacing an R&S NRP-Zxx with an R&S NRPxxS[N]

The new R&S NRPxxS[N] sensors are compatible with the R&S NRP-Zxx series of power sensors.

New power sensor	Replaces this sensor
R&S NRP8S/R&S NRP8SN - USB connected	R&S NRP-Z11
R&S NRP18S/R&S NRP18SN - USB connected	R&S NRP-Z21
R&S NRP33S/R&S NRP33SN - USB connected	R&S NRP-Z31
R&S NRP40S/R&S NRP40SN - USB connected	R&S NRP-Z41
R&S NRP50S/R&S NRP50SN - USB connected	R&S NRP-Z61

To use the new power sensors, it may be required to update the drivers. For PC based software applications (R&S NRPV and R&S Power Viewer Plus), please install latest NRP Toolkit (V 4.3 or higher).

For using the sensors with R&S NRP, R&S NRP2, signal generators, spectrum analyzers or other Rohde & Schwarz instruments, please Install the latest firmware version.

3.9.1 The most important differences

The new and the old sensors are compatible as far as possible. However, there are some differences:

- The state of the sensors is indicated by a LED, see "Status LED" on page 13.
- After connecting the R&S NRPxxS[N] sensors, the first measurement can be available after 7 seconds (R&S NRP-Zxx: 4 seconds).

3.9.2 Prerequisites

Application / used with	Prerequisites
R&S NRP/NRP2	Firmware Version 7.11 or higher must be installed.
R&S PC software applications, like: • R&S NRP Toolkit • R&S NRPV • R&S Power Viewer Plus	It is necessary is to install the R&S NRP Toolkit version V 4.3 or higher, see Chapter 3.3, "Using the Power Sensors with the R&S NRP Toolkit", on page 23. Older versions do not support the R&S NRPxxS[N] power sensors. The new R&S NRP Toolkit is compatible with both the R&S NRP-Zxx and the R&S NRPxxS[N] so that its installation will not affect the usage of the R&S NRP-Zxx power sensors. After the new R&S NRP Toolkit is installed, you can connect the R&S NRPxxS[N] power sensor to the computer and use it with Rohde & Schwarz software applications or your own programs.
R&S signal generators, spectrum analyzers or other instruments	Install the latest firmware version (released December 2014 or later)

4 The WebGUI

The WebGUI is an alternative way to operate the R&S NRPxxSN LAN power sensors.

This chapter provides a description of the parameters used for setting a power measurement with the WebGUI.

For a detailed description of how to connect the sensor to a device and start the WebGUI, refer to Chapter 3.6, "Using the WebGUI of the Network Sensors ", on page 29.

4.1 The WebGUI Interface

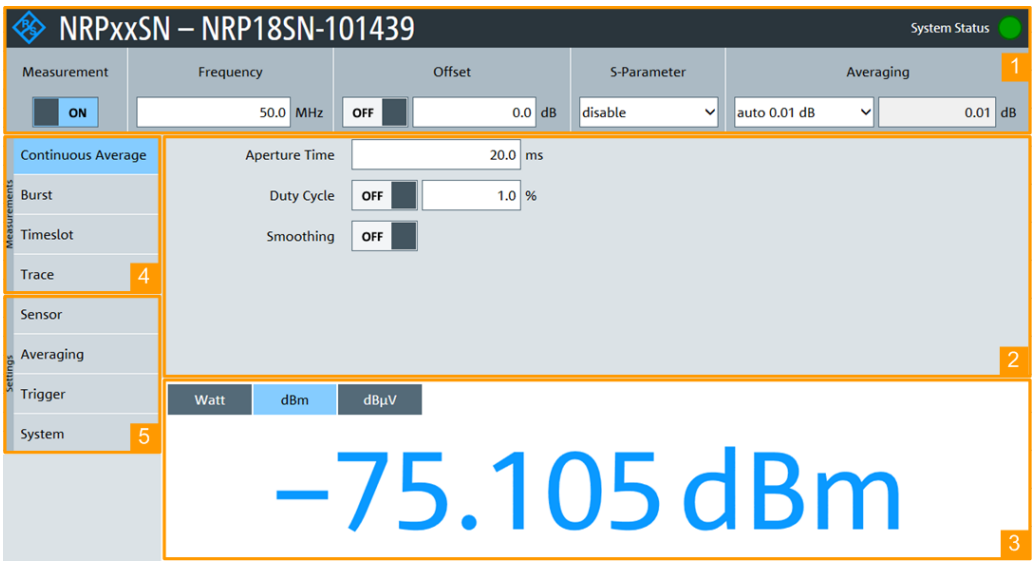


Figure 4-1: Explanation of the WebGUI interface

1 = Common settings
2 = Parameters
3 = Result
4 = Measurement tabs
5 = Settings tabs

The WebGUI interface can be divided in several sections:

- Common settings: includes parameters used in all measurement modes
- "Measurement" tabs: includes the available measurement modes
- "Settings" tabs: includes parameters for general sensors configuration
- "Parameter": in this section the display changes according to the selected tab, and contains all parameters that can be set for the selected measurement type or setting
- "Result": this section displays the measurement result for the selected measurement mode. It can display only a value or a graph, according to the selected measurement mode.

For detailed information on specific settings refer to the following chapters.

Setting the Unit

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

Figure 4-2: Parameter

1 = Parameter name
2 = Value
3 = Unit

The following abbreviations are available:

Unit	Keyboard Key
Decibel	*d*
Hertz	*h*
Second	*s*
Volt	*v*
Watt	*w*

Unit Multiples	Keyboard Key
Giga	*g*
Mega	*m*
Kilo	*k*
mili	*m*
micro	*u*
nano	*n*

Example:

For setting the unit to 1 GHz, type *1g*.

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

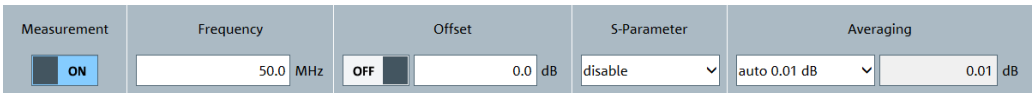
Example:

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

If you want to revert the value to Watt, enter *50uW* to set a value of 50.00 µW and changes the unit for the further numeric entries.

4.2 Common Settings

The following parameters set common sensor settings that are available for all measurement modes.



System Status
Confirms that there is a connection between the sensor and the remote PC and that the sensor is recognized by the software.

The presentation of this symbolic LED mirrors the physical LED of the sensor.

Measurement
Switches the measurement on and off.

Remote command:
`INITiate:CONTinuous` on page 117

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

Remote command:
`[SENSe<Sensor>:]FREQuency` on page 109

Offset State
Activates/deactivates the usage of the level offset.

Remote command:
`[SENSe<Sensor>:]CORRection:OFFSet:STATe` on page 112

Offset
Adds a fixed level offset in dB to account for external losses.

Remote command:
`[SENSe<Sensor>:]CORRection:OFFSet` on page 112

S-Parameter
Selects the mode used for the S-parameters. S-parameters are used to compensate for a component (attenuator, directional coupler) connected ahead of the sensor.

Averaging Mode
Sets the automatic averaging filter mode.

"manual" Auto averaging is turned off. A fixed filter value is used, that can be set in the field next to the "Averaging Mode"

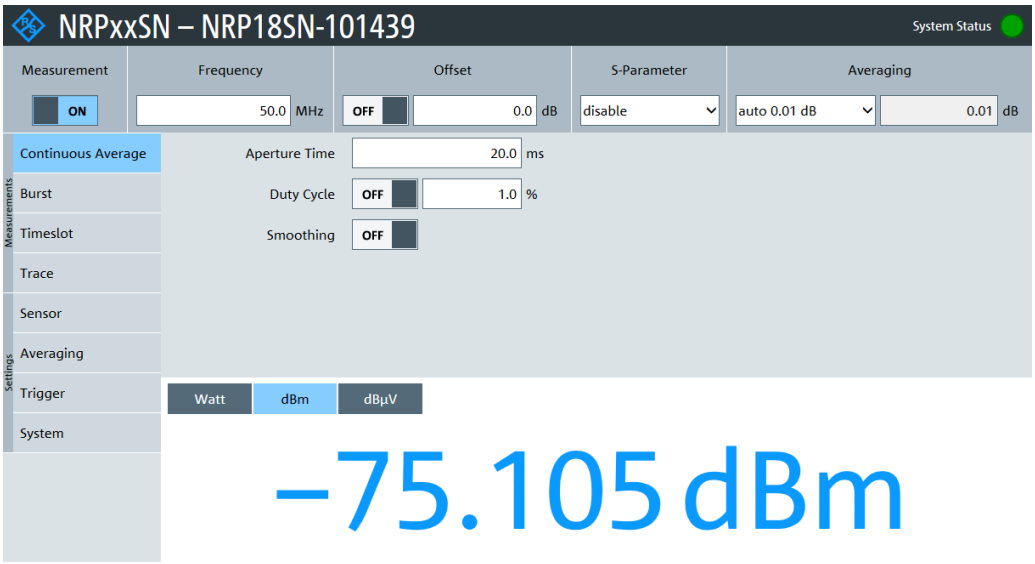
"auto 1dB/ auto 0.1dB/ auto 0.01dB /auto 0.001dB "
Uses an automatic averaging filter with the respective resolution index.

"noise content" Predefines the compliance to an exactly defined noise component. You can set this value in the field next to the "Averaging Mode".

4.3 Continuous Average Settings

The following parameters set a Continuous Average measurement.

For a detailed description of the Continuous Average mode and its remote commands refer to Chapter 6.4.1, "Configuring a Continuous Average Measurement", on page 94.



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

Remote command:
`[SENSe<Sensor>:][POWer:][AVG:]APERture` on page 95

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

Remote command:
[SENSe<Sensor>:]CORRection:DCYCle:STATe on page 111
[SENSe<Sensor>:]CORRection:DCYCle on page 111

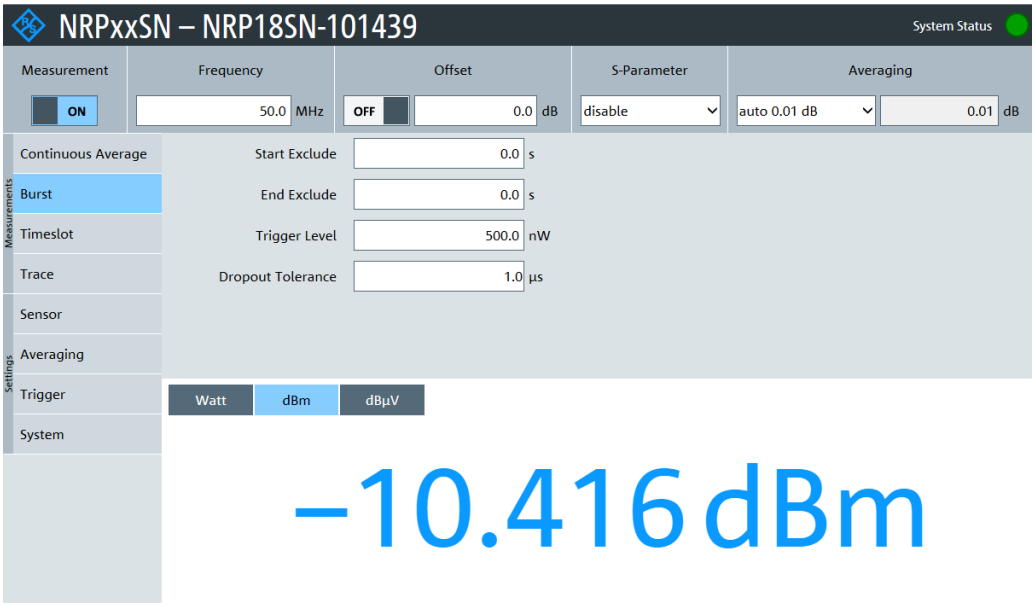
Smoothing
Activates the smoothing filter, a steep-cut off digital lowpass filter. The filter reduces result fluctuations caused by modulation.

Remote command:
[SENSe<Sensor>:][POWer:][AVG:]SMOothing:STATe on page 96

4.4 Burst Settings

The following parameters set a Burst Average measurement.

For a detailed description of the Burst Average mode and its remote commands refer to Chapter 6.4.2, "Configuring a Burst Average Measurement", on page 96.



Start Exclude
Sets a time that is to be excluded at the beginning of the measurement period.

Remote command:
[SENSe<Sensor>:]TIMing:EXCLude:STARt on page 110

End Exclude
Sets a time that is to be excluded at the end of the measurement period.

Remote command:
[SENSe<Sensor>:]TIMing:EXCLude:STOP on page 110

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

Remote command:
TRIGger:LEVel on page 121

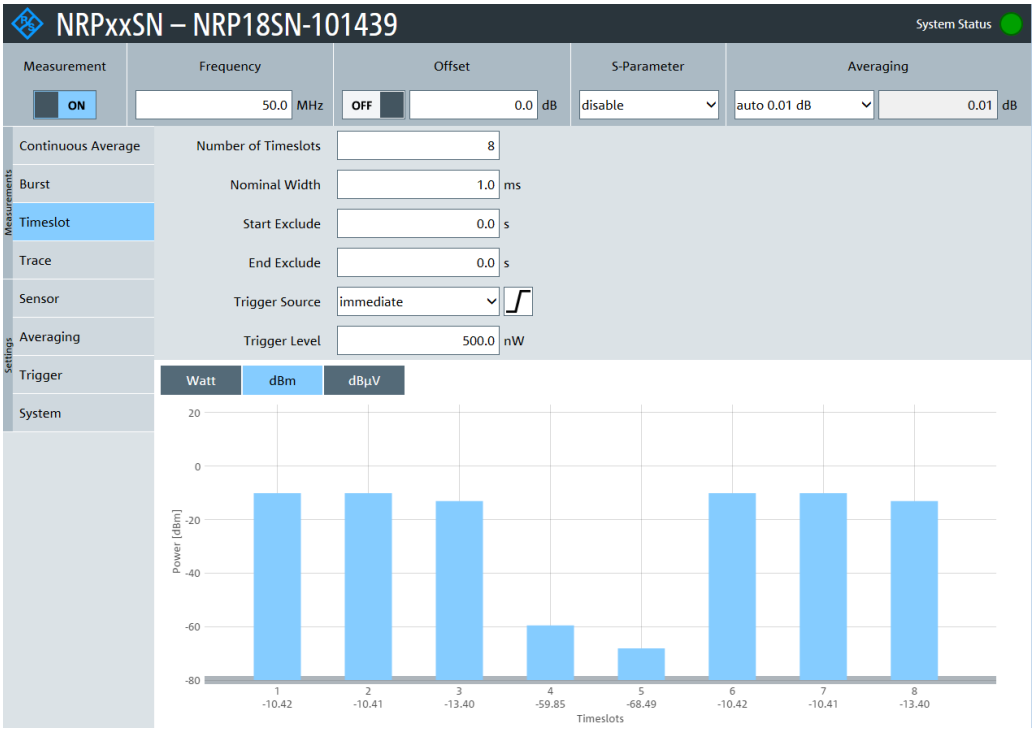
Dropout Tolerance
Sets the dropout time. This is a time interval in which the pulse end is only recognized if the signal level no longer exceeds the trigger level.

Remote command:
[SENSe<Sensor>:][POWer:]BURSt:DTOLerance on page 98

4.5 Timeslot Settings

The following parameters set a Timeslot Average measurement.

For a detailed description of the Timeslot Average mode and its remote commands refer to Chapter 6.4.3, "Configuring a Timeslot Average Measurement", on page 98.



Number of timeslots
Sets the number of simultaneously measured timeslots. Up to eight slots can be selected.

Remote command:
[SENSe<Sensor>:][POWer:]TSLot[:AVG]:COUNt on page 100

Nominal Width
Sets the length of a timeslot in seconds.

Remote command:
[SENSe<Sensor>:][POWer:]TSLot[:AVG]:WIDTh on page 100

Start Exclude
Sets a time that is to be excluded at the beginning of the measurement period.

Remote command:
[SENSe<Sensor>:]TIMing:EXCLude:STARt on page 110

End Exclude
Sets a time that is to be excluded at the end of the measurement period.

Remote command:
[SENSe<Sensor>:]TIMing:EXCLude:STOP on page 110

Trigger Source
Selects the trigger source.

Remote command:
TRIGger:SOURce on page 122

Trigger Slope
Sets the polarity of the active slope of the externally or internally applied trigger signal.

"Positive" The rising edge of the trigger signal is used for triggering.

"Negative" The falling edge of the trigger signal is used for triggering.

Remote command:
TRIGger:SLOPe on page 122

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

Remote command:
TRIGger:LEVel on page 121

4.6 Trace Settings

The following parameters set a Trace measurement.

For a detailed description of the Trace measurement mode and its remote commands refer to Chapter 6.4.4, "Configuring a Trace Measurement", on page 101 .

Trace Time
Sets the trace length.

Remote command:
[SENSe<Sensor>:]TRACe:TIME on page 106

Trace Offset Time
Sets the relative position of the trigger event in relation to the beginning of the trace measurement sequence. This is used to specify the start of recording for the Trace mode.

Remote command:
[SENSe<Sensor>:]TRACe:OFFSet:TIME on page 105

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

Remote command:
[SENSe<Sensor>:]TRACe:POINts on page 105

Trigger Source
Selects the trigger source.

Remote command:
TRIGger:SOURce on page 122

Trigger Slope
Sets the polarity of the active slope of the externally or internally applied trigger signal.

"Positive" The rising edge of the trigger signal is used for triggering.

"Negative" The falling edge of the trigger signal is used for triggering.

Remote command:
TRIGger:SLOPe on page 122

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

Remote command:
TRIGger:LEVel on page 121

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

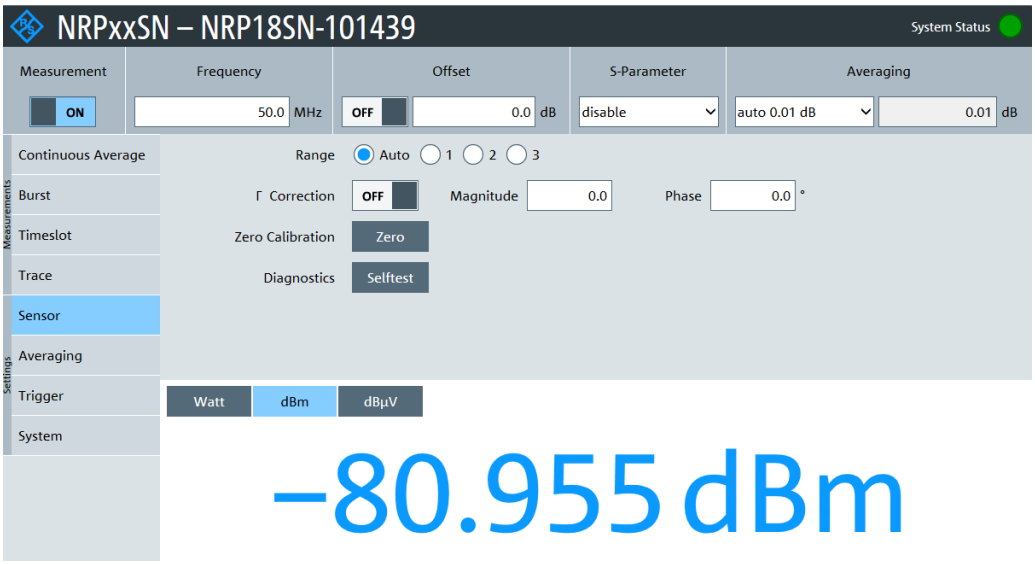
Remote command:
TRIGger:DELay on page 118

4.7 Sensor Settings

The following parameters optimize the measurement results for specific measurement requirements.

For a detailed description of the Timeslot Average mode and its remote commands refer to Chapter 6.4.3, "Configuring a Timeslot Average Measurement", on page 98.

In the "Sensor" tab you can make settings for the optimization of your measurement results according to the specific measurement requirements.



Range
Selects which path of the sensor is used for the measurement.

Γ Correction
Enables the use of the complex reflection coefficient of the signal source (Γ_{source}) The Γ_{source} coefficient is defined with "Magnitude" and "Phase".

Remote command:
`[SENSe<Sensor>:]SGAMma:CORRection:STATe` on page 113

Magnitude
Sets the magnitude of the complex reflection coefficient of the source (Γ_{source}).

A value of 0.0 corresponds to an ideal matched source and a value of 1.0 to total reflection.

Remote command:
`[SENSe<Sensor>:]SGAMma:MAGNitude` on page 114

Phase
Sets the phase angle of the complex reflection coefficient of the source (Γ_{source}).

Remote command:
`[SENSe<Sensor>:]SGAMma:PHASe` on page 114

Zero Calibration
Performs zeroing using the signal at the sensor input.

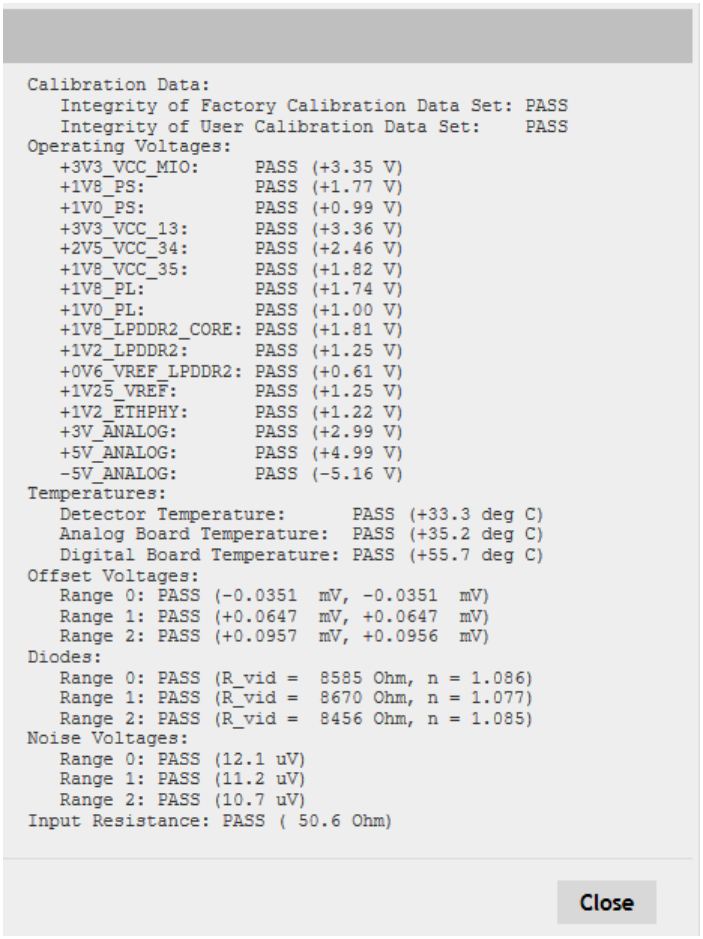
The sensor must be disconnected from all power sources.

Remote command:
`CALibration:ZERO:AUTO` on page 129

Diagnostics
Triggers a selftest of the sensor.

Note: 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*.

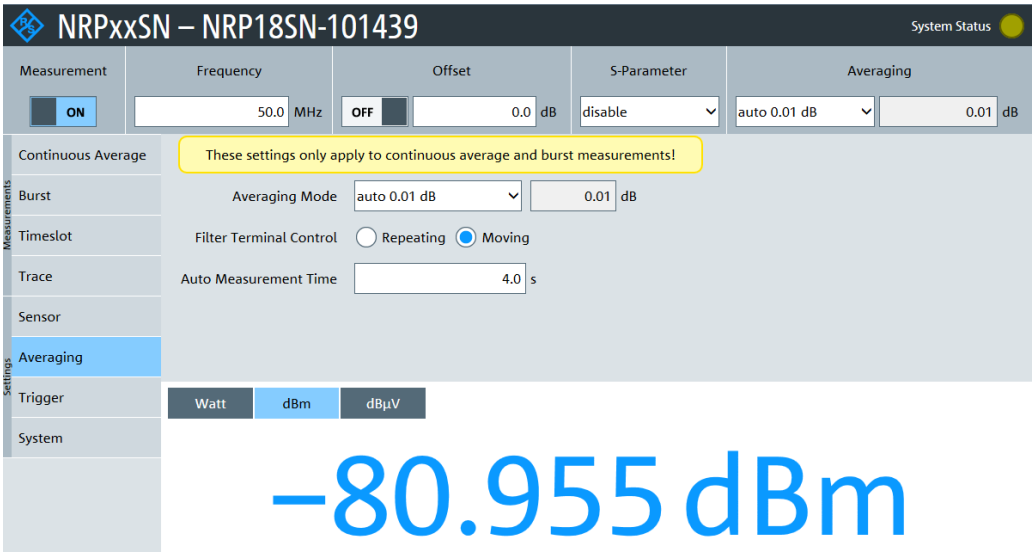
The results of the selftest are shown in a dialog, which appears after the test is completed.



Remote command:
`TEST:SENSor?` on page 128

4.8 Averaging Settings

In the "Averaging" tab you can define the settings for automatic averaging. The settings in this dialog only apply for Continuous average, Burst average and Timeslot measurements.



Averaging Mode
Sets the automatic averaging filter mode.

"manual" Auto averaging is turned off. A fixed filter value is used, that can be set in the field next to the "Averaging Mode"

"auto 1dB/ auto 0.1dB/ auto 0.01dB /auto 0.001dB "
Uses an automatic averaging filter with the respective resolution index.

"noise content" Predefines the compliance to an exactly defined noise component. You can set this value in the field next to the "Averaging Mode".

Filter Terminal Control
Sets the terminal control mode, defining how the measurement results are output.

As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output. It is obtained from the new measured value and the other values stored in the filter.

"Repeating" The filter doesn't output a result before it is settled. Depending on the filter depth, this may result in slower update rates.
This mode is recommended for automatic systems.

"Moving" The averaging filter provides intermediate results while is it setting. This leads to faster update rates and a visible settlement.
This mode is recommended for manual measurements.

Remote command:
`[SENSe<Sensor>:]AVERage:TCONtrol` on page 109

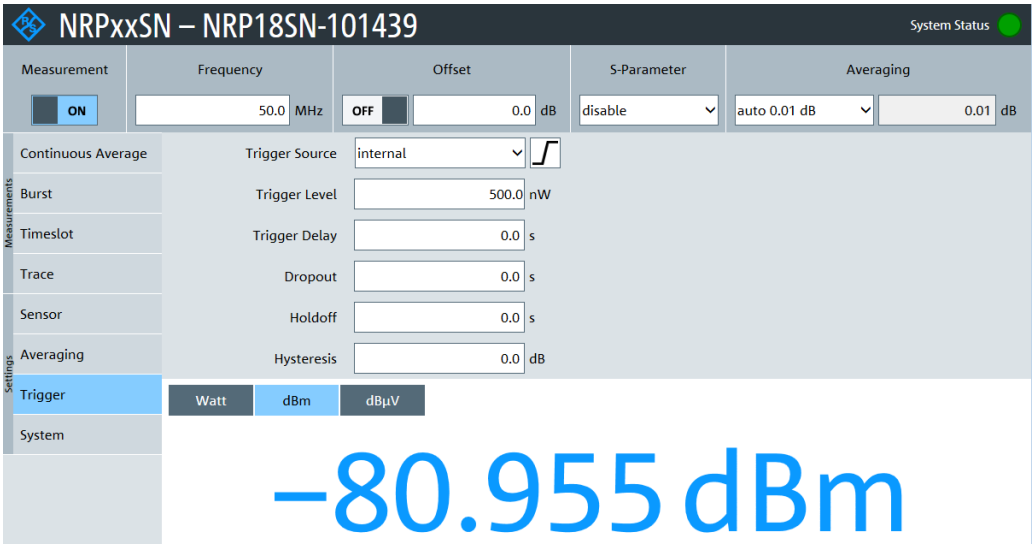
Auto Measurement Time
Available only when "Averaging Mode" is set to "noise content".

Sets an upper limit for the settling time of the auto-averaging filter, thus limiting the length of the filter.

Remote command:
[SENSe<Sensor>:]AVERage:COUNt:AUTO:MTIMe on page 107

4.9 Trigger Settings

In the "Trigger" tab you can define the conditions that have to be fulfilled for a measurement to be triggered.



Trigger Source
Selects the trigger source.

Remote command:
TRIGger:SOURce on page 122

Trigger Slope
Sets the polarity of the active slope of the externally or internally applied trigger signal.

"Positive" The rising edge of the trigger signal is used for triggering.

"Negative" The falling edge of the trigger signal is used for triggering.

Remote command:
TRIGger:SLOPe on page 122

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

Remote command:
TRIGger:LEVel on page 121

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

Remote command:
TRIGger:DELay on page 118

Holdoff
Sets the hold off time, a period after a trigger event within which all further trigger events are ignored.

Remote command:
TRIGger:HOLDoff on page 120

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

Remote command:
TRIGger:DTIMe on page 119

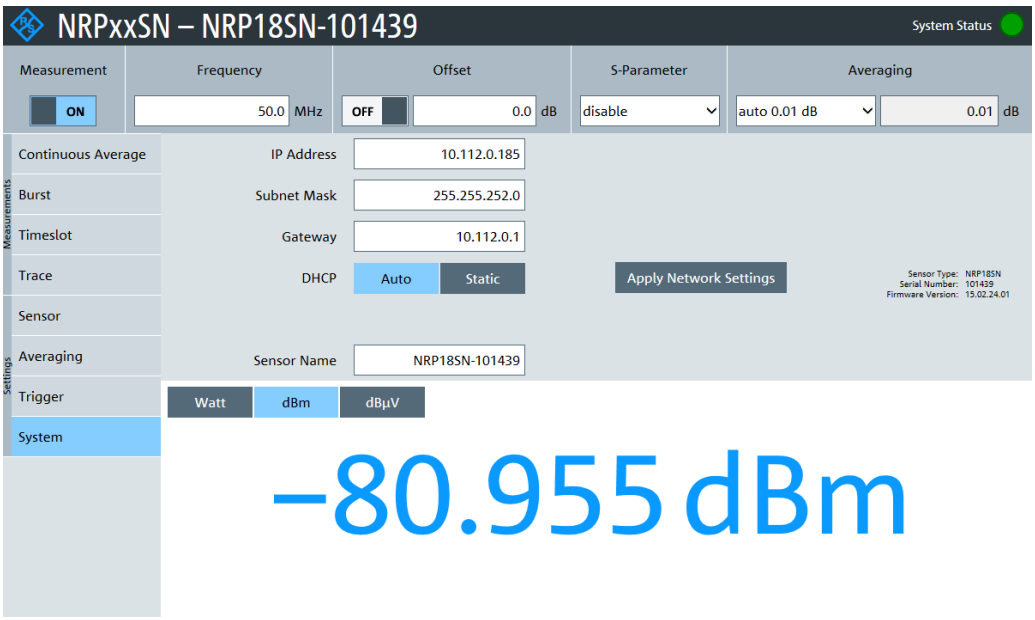
Hysteresis
Sets the hysteresis in dB.

Setting the trigger hysteresis to a value other than 0 dB will prevent another trigger from occurring until the measurement level has fallen below (at positive trigger slope) or raised above (at negative trigger slope) the trigger threshold by at least this value.

Remote command:
TRIGger:HYSTeresis on page 120

4.10 System Settings

In the "System" tab you can configure the settings of the general network environment and specific identification parameters of the instrument in the network.



IP Address
Sets the IP address of the sensor.

Remote command:
SYSTem:COMMunicate:NETWork:IPADdress on page 78

Subnet Mask
Sets the subnet mask.

The subnet mask consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.

Remote command:
SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK on page 79

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

Remote command:
SYSTem:COMMunicate:NETWork:IPADdress:GATeway on page 78

DHCP
Selects the mode for assigning the IP address.

"Auto"	Assigns the IP address automatically, provided the network supports DHCP (**D**ynamic **H**ost **C**onfiguration **P**rotocol)
"Static"	Enables assigning the IP address manually.

Remote command:
SYSTem:COMMunicate:NETWork:IPADdress:MODE on page 78

Sensor Name
Sets the sensor name. This name appears in the "Common settings " of the WebGUI.

As long as no sensor name is explicitly specified by the user, the sensor name defaults to the hostname.

Remote command:
SYSTem[:SENSor]:NAME on page 87

Apply Network Settings
After you have made the required network settings changes you can apply them to the sensor by pressing the "Apply Network Settings" button.

5 R&S NRP Toolkit Program Modules

In this chapter some applications that are part of the R&S NRP Toolkit are described.

5.1 S-Parameters

For more information on the fundamentals of the S-parameters and for application example see also 1GP70: Using S-Parameters with R&S®NRP-Z Power Sensors.

S-parameter correction compensates for the losses and reflections introduced by a component – such as an attenuator, directional coupler, or matching pad – that is attached to a power sensor. Using S-parameters instead of a fixed offset increases measurement accuracy by accounting for the interaction between the sensor and the component. This shifts the sensor's reference plane from the sensor's RF connector to the input of the device that is being applied externally.

All R&S NRPxxS[N] power sensors make it possible to compensate for the influence of any two-port devices between the signal source and the sensor input. As a result, it is possible to calculate the power P that the signal source actually delivers. Examples of such two-port devices include attenuators, matching pads, minimum-loss pads and waveguide adapters. One precondition for such compensation is that a complete set of S-parameter data must be available for the two-port device in the frequency range required by the application.

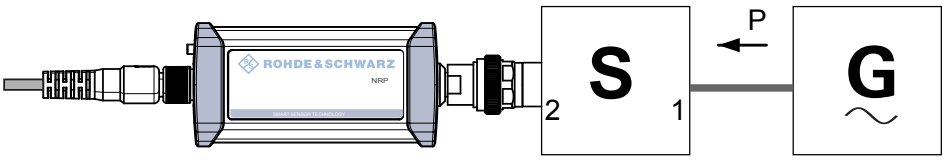
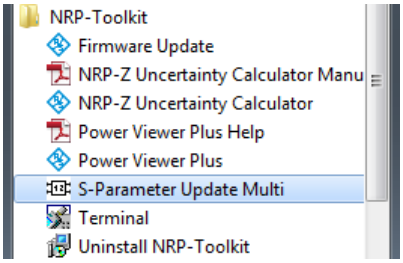


Figure 5-1: Operation with twoport between signal source and sensor input

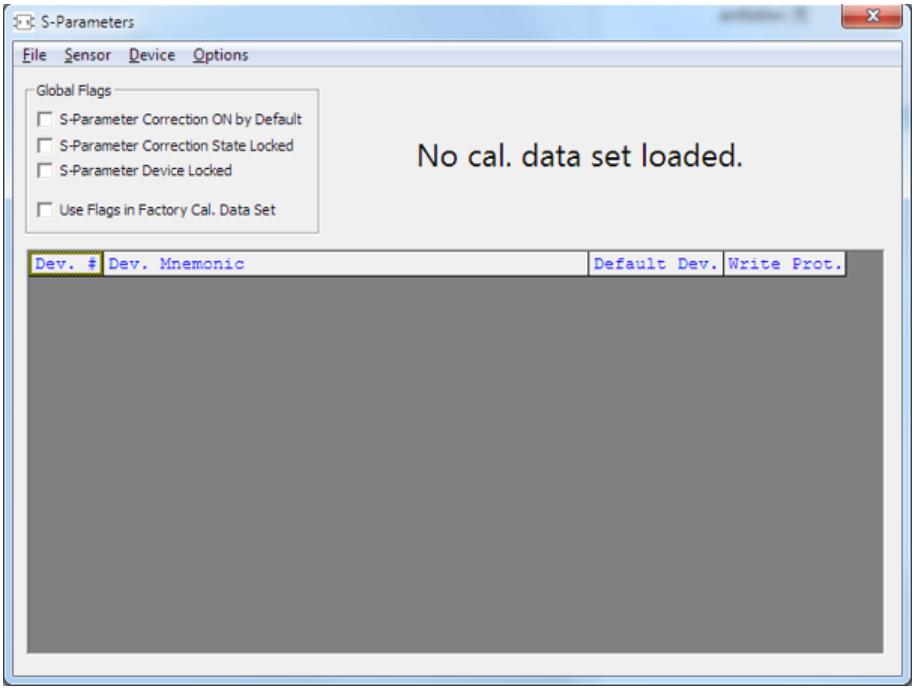
5.1.1 The S-Parameters Tool GUI Interface

To start the S-Parameter Tool:

► Select "Start Menu > NRP Toolkit > S-Parameter Update Multi".

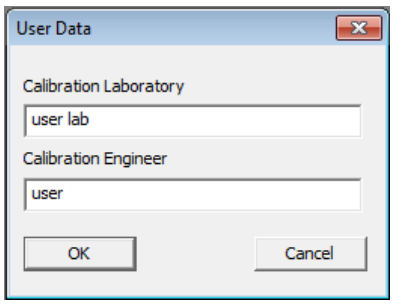


The "S-Parameters" dialog opens.

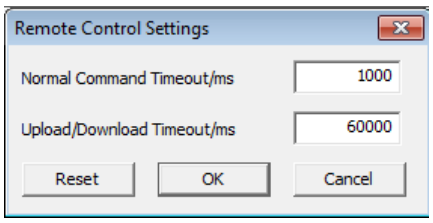


The S-Parameters Tool interface can be divided into several sections:

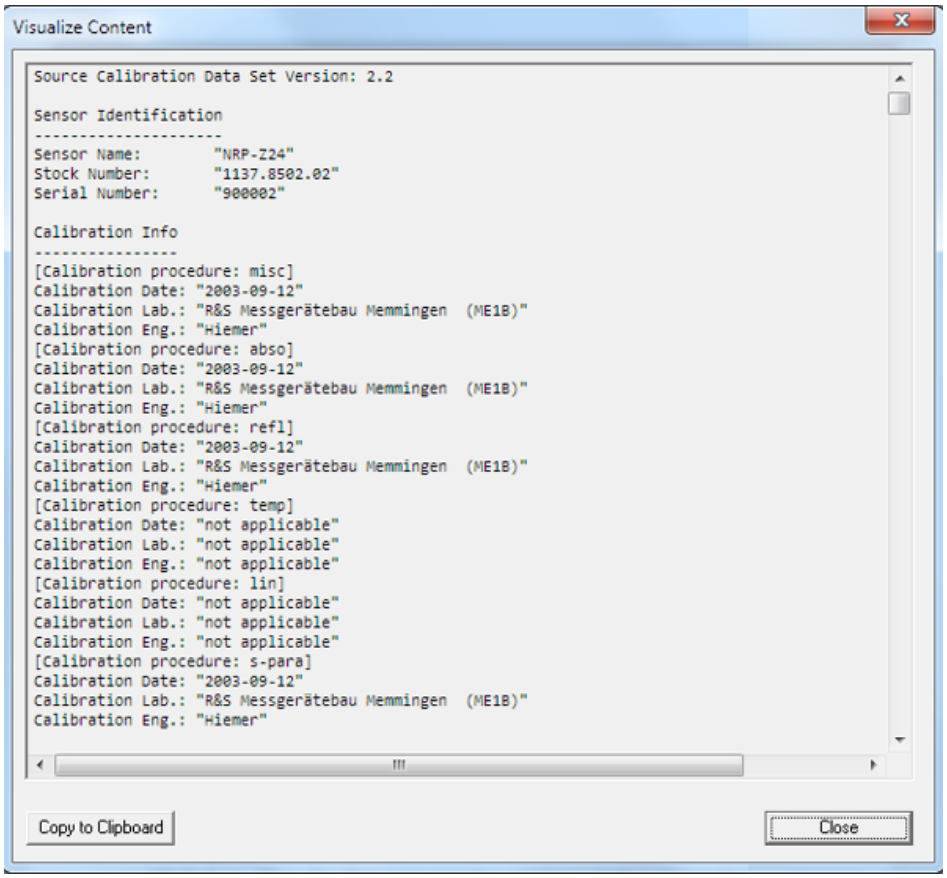
- Menu bar containing the following submenus:
  - "File"
    This submenu provides options for loading and saving calibration data files.
  - "Sensor"
    This submenu provides options for loading and saving calibration data directly from or to the sensor.
  - "Device"
    This submenu provides options for editing the table of s-parameter devices.
  - "Options"
    This submenu provides options to edit user data, change remote control time-outs, and display calibration data as plain text.
    Click "User Data..." to open the "User Data" dialog. Here you can enter the name of the calibration laboratory and the calibration engineer that will be stored in the calibration data set if changes are made.



Click "Remote..." to open the "Remote Control Settings" dialog. It is normally not necessary to change timeouts.



Click "Show Cal. Data" to display the content of the calibration data set that has been loaded either from a file of directly from a sensor as a plain text. You can copy the text output to the clipboard by clicking "Copy to Clipboard."

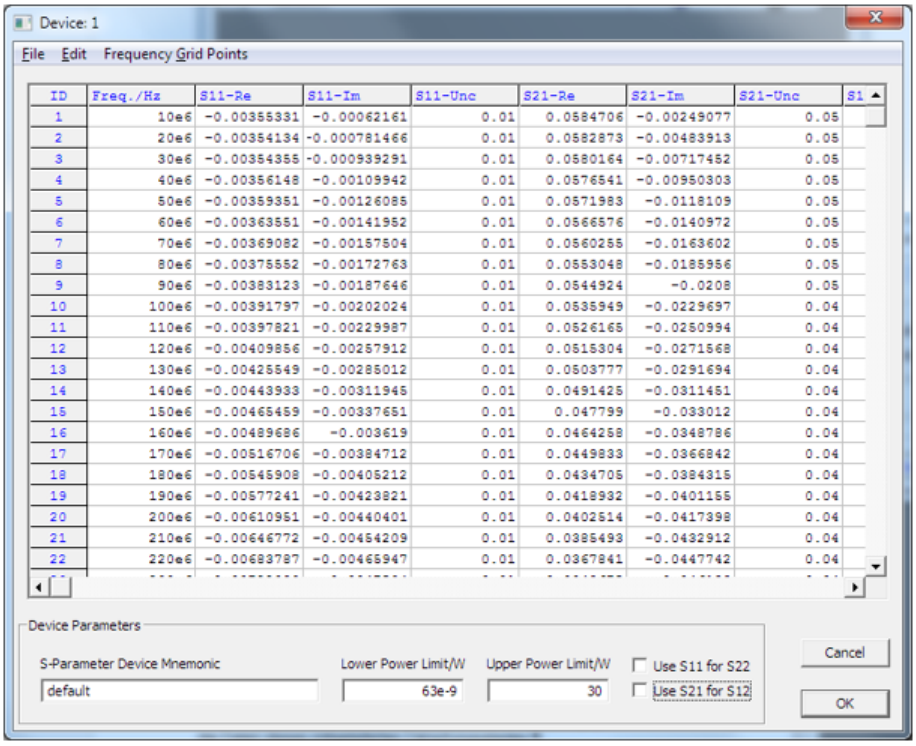


- "Global Flags"

In this section you can select how the sensor behaves regarding s-parameter corrections:

– "S-Parameter Correction ON by Default": If this option is enabled, the s-parameter correction is activated automatically when the sensor is started.
– "S-Parameter Correction State Locked": If this option is enabled, the state that is selected with "S-Parameter Correction ON by Default" is locked and cannot be changed through the SCPI command `SENSe:CORRection:SPDevice:STATe` or manually through the R&S NRP2 base unit.
– "S-Parameter Device Locked": If this option is enabled, the s-parameter device that is selected as the default device in the table of s-parameter devices is locked and cannot be changed through the SCPI command `SENSe:CORRection:SPDevice:SELect` or manually through the R&S NRP2 base unit.
The default s-parameter device is the s-parameter device that is selected when the sensor is started.
– "Use Flags in Factory Cal. Data Set": Available only for the latest R&S power sensors. These sensors feature two different calibration data sets - a factory calibration data set that contains all factory calibration data and a user calibration data set that contains the s-parameter devices loaded by the user.
Note: You must uncheck this option when you have added s-parameter devices and configured the global flags. Otherwise, it may not be possible to activate s-parameter correction because the flags in the factory calibration data set prevent it.

- "Device Table"
Shows a list of all s-parameter devices that are available in the calibration data set. If you double-click on a device, a dialog is opened that allows to import, export, and edit s-parameter data.



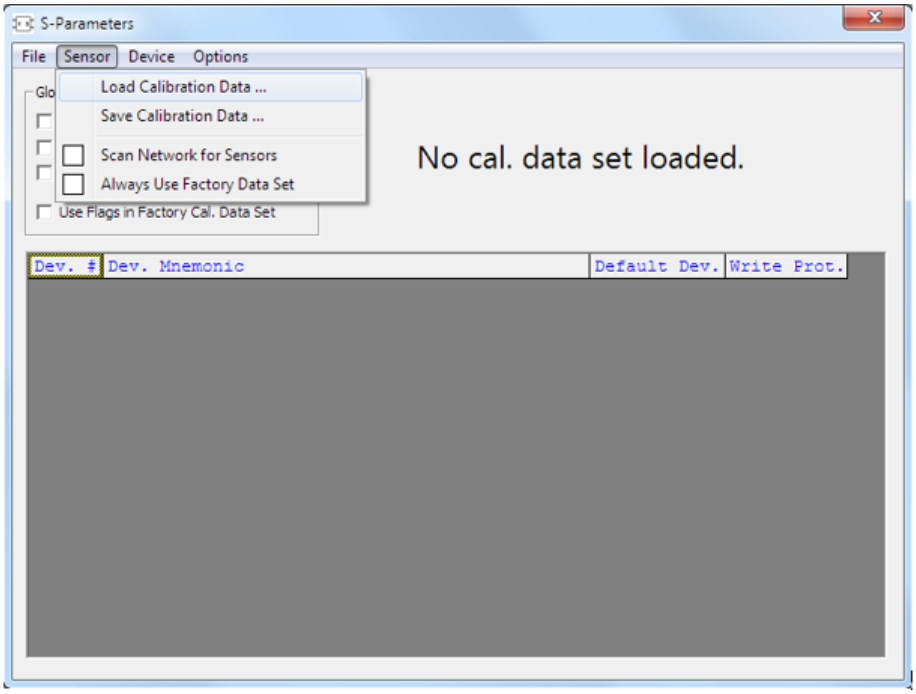
5.1.2 Performing Configuration Tasks

In this chapter different configuration tasks that can be performed with the power sensors and the "S-Parameter Update Multi" tool are described.

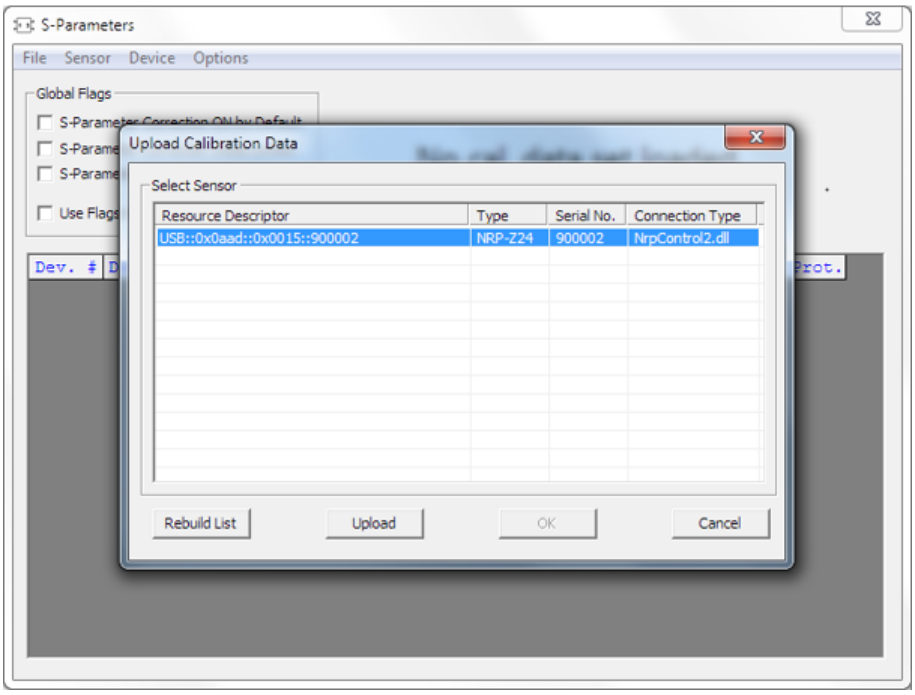
Loading a calibration data set from a power sensor

We presume that the sensor is connected to the computer and there is a connection established.

1. Open the "S-Parameter Update Multi" program.
2. Select "Sensor > Load Calibration Data...".



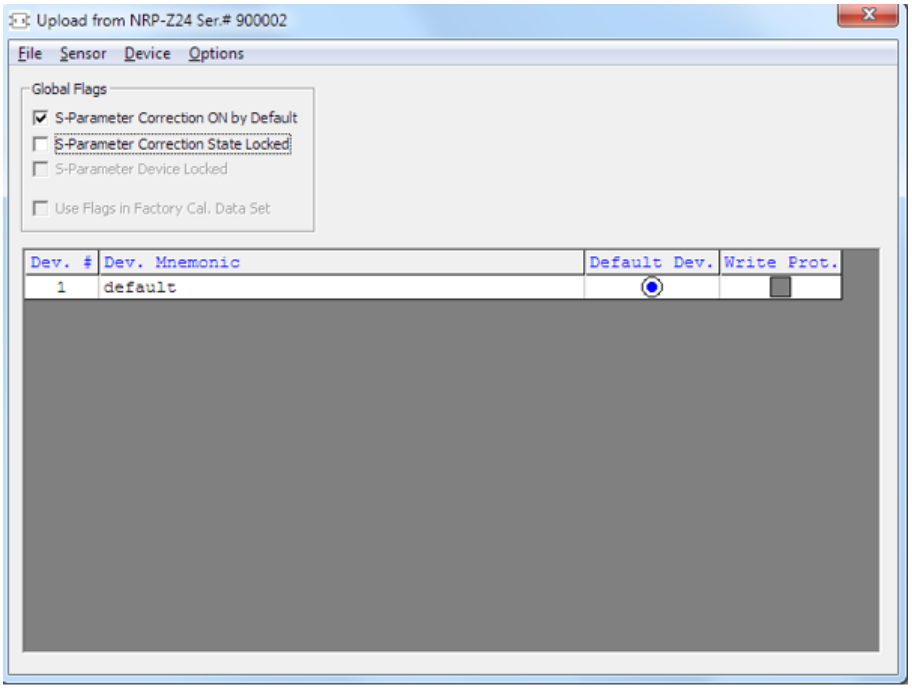
The "Upload Calibration Data" dialog opens. It shows a list of the available sensors.
Note: If you cannot find your sensor in the list (for example because of reconnecting the sensor) you can reload the list by clicking the "Rebuild List" button.



3. Click the "Upload" button to load calibration data from the sensor.
After the upload is finished, the "OK" button is enabled. Press "OK" to apply the changes.

If you want to discard the changes, you can close the dialog by pressing "Cancel".

After a successful upload the name and serial number is shown in the name of the main dialog.

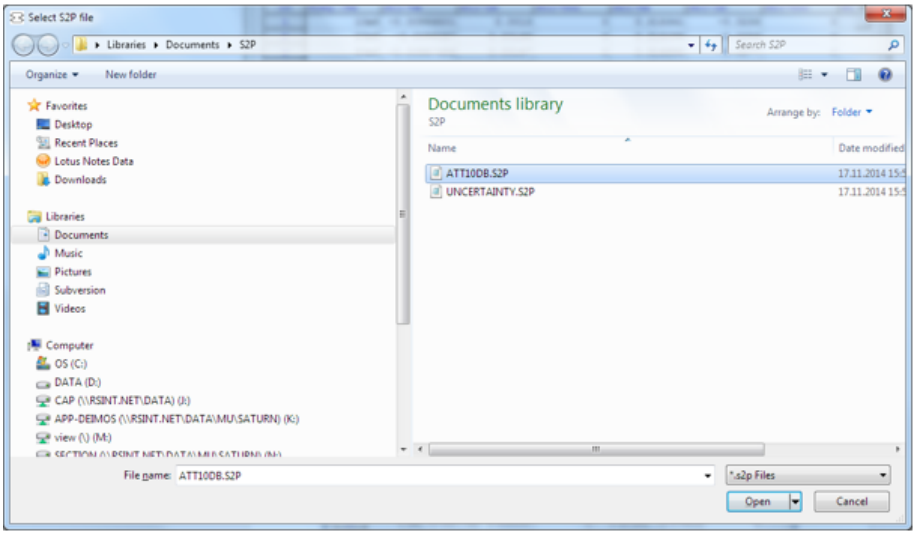


4. It is recommended to make a backup of the calibration data set before making any changes.
   To create a backup, click "File > Save Calibration Data...".

   A window opens where you can select where you want to save the calibration data.

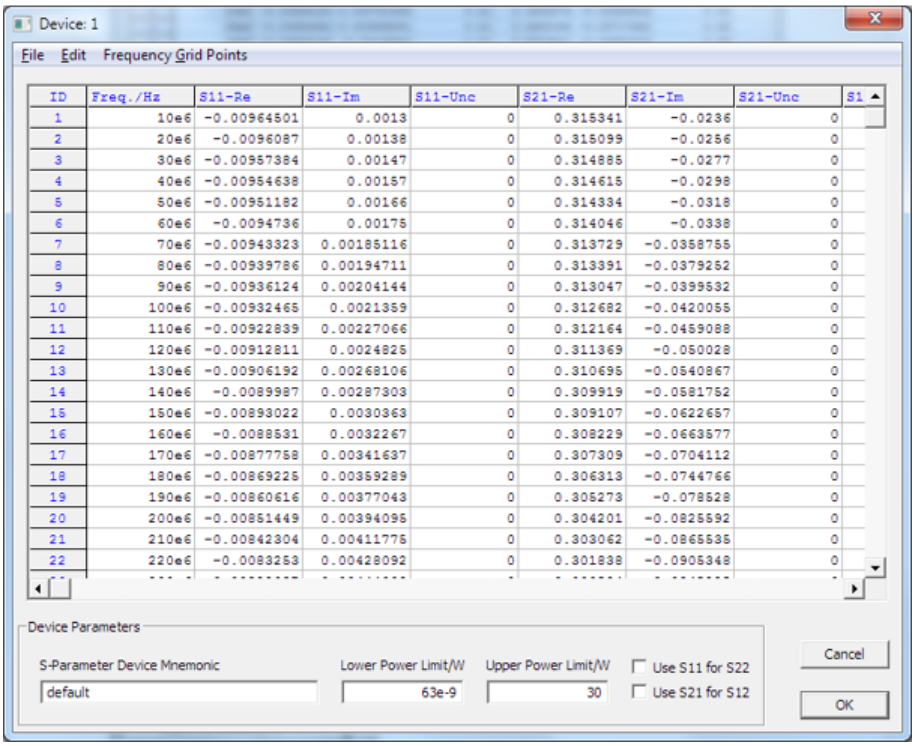
Changing the s-parameter data

1. Select "File> Import S2P".



2. In the window select the file you want to import and confirm with "Open".

   The data from the selected file is loaded in the device table.
   All uncertainties are set to zero.



3. If needed, load uncertainty data. See "Loading an uncertainty parameter file" on page 62.

4. Check the entries in the "S-Parameter Device Mnemonic", "Lower Power Limit/W" and "Upper Power Limit/W" fields and change them if required. For example, the lower and upper power limits are deduced from the power limits of the sensor itself and the minimum attenuation of the s-parameter device. If the "Upper Power Limit/W" entry is higher than the power dissipation rating of the attenuator, it should be reduced accordingly.

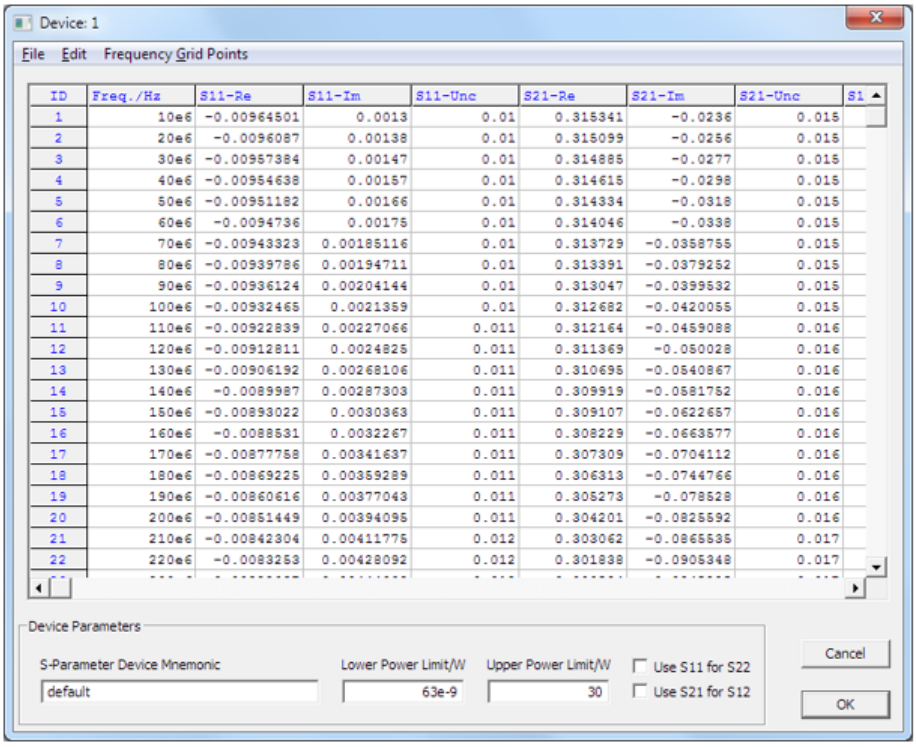
5. Click "OK" to apply the changes or "Cancel" to discard them.

Loading an uncertainty parameter file

1. Select "File > Import uncertainties...".

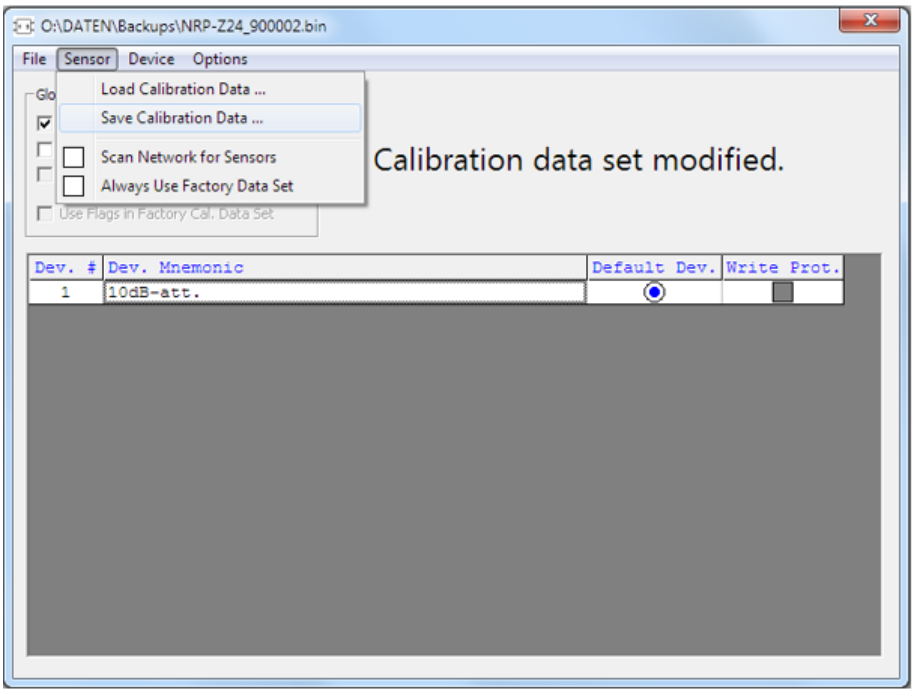
2. In the "Select S2P file" dialog, select the file you want to import and confirm with "Open".

   The data from the selected file is loaded in the device table.

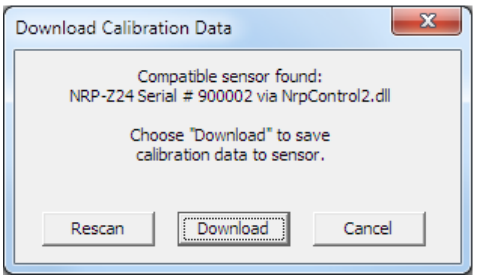


Saving the calibration data to the sensor

1. Select "Sensor > Save Calibration Data ...".

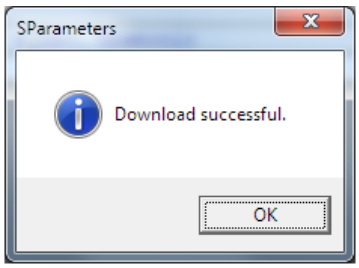


The following dialog appears:



2. Confirm that the correct sensor was selected by pressing "Download".

   After a successful transfer of the data to the sensor a dialog pops up to confirm it. The sensor can be used with the new s-parameter data.



5.1.3 Structure of S2P and Uncertainty Data Files

Structure of S2P measurement data files

S2P files are human readable text files that contain header information as well as the complex S-parameters of the device under test in columns. This chapter briefly describes the format of the S2P file.

An S2P measurement data file has the following structure (square brackets indicate that the enclosed content is optional):

- **Option line**
  The option line has the format *#[<frequency unit>][<parameter>][<format>][<R n>]*, where:
  - #
    Identifies the option line.
  - *<frequency unit>*
    Possible values are Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
  - *<parameter>* For s-parameter files If a parameter is not specified, S is implicitly assumed.
  - *<format>*
    Possible values are 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 n>*

R is optional and followed by the reference impedance in Ω. 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].

- **Measurement frequencies**
  The measurement frequencies are listed in ascending order and are specified as follows:
  f_l $s_{11}(f_l)$ $s_{21}(f_l)$ $s_{12}(f_l)$ $s_{22}(f_l)$
  where f_l is the l-th frequency and $s_{jk}(f_l)$ is the display format as specified in the option line:
  - $|s_{jk}(f_l)|$ $arg\ s_{jk}(f_l)$
    display format for linear magnitude and phase in degree (MA)
  - $20.lg|s_{jk}(f_l)|$ $arg\ s_{jk}(f_l)$
    display format for magnitude in dB and phase in degree (DB)
  - $Re|s_{jk}(f_l)|$ $Im|s_{jk}(f_l)|$
    display format for real and imaginary part (RI)
- **Comments**
  Any line starting with an exclamation mark (*!*) is interpreted as a comment line.

Structure of uncertainty data files

An uncertainty data file has the following structure (square brackets indicate that the enclosed content is optional):

- **Option line**
  The option line has the format *#[<frequency unit>]<parameter>[<format>][<R n>]*, where:
  - *#*
    Identifies the option line.
  - *<frequency unit>*
    Possible values are Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
  - *<parameter>*
    U must be specified for uncertainty data files. If a parameter is not specified, S is implicitly assumed and as a result an error message is triggered.
  - *<format>*
    This value is ignored in uncertainty measurement files. The entry is therefore irrelevant.
  - *<R n>*
    R is optional and followed by the reference impedance in Ω. 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].
- **Measurement frequencies**
  The measurement frequencies are listed in ascending order and are specified as follows:
  f_l $unc[s_{11}(f_l)]$ $unc[s_{21}(f_l)]$ $unc[s_{12}(f_l)]$ $unc[s_{22}(f_l)]$

where f_l is the l-th frequency and $unc[\ s_{jk}(\ f_l)]$ is the uncertainty of the s-parameters that is forwarded as follows:

– as extended absolute uncertainty (k = 2) for the magnitude of reflection parameters s_{11} and s_{22}

– as extended uncertainties (k = 2) in dB for the magnitude of transmission parameters s_{21} and s_{12}

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

5.2 Firmware Update

5.2.1 Installation of New Firmware

Use the Firmware Update program (PureFW) to load new firmware for the power sensors. It is part of the R&S NRP Toolkit that is supplied on a CD-ROM together with the power sensors.

The most recent firmware versions can be downloaded from the Rohde & Schwarz homepage on the Internet, since the CD-ROM accompanying the power sensors contains the firmware status at the time of delivery.

5.2.2 Hardware and Software Requirements

The system requirements to perform a firmware update are as follows:

- PC with free USB port
- NRP-ZKU interface cable
- Operating system Microsoft Windows 7, Microsoft Windows 8 or Microsoft Windows 10
- **VISA software must be installed on your PC.**
- The R&S NRP Toolkit software must be installed on your PC (includes Firmware Update program).
- A Rohde & Schwarz update file (*.rsu) for the sensor must be available.

The latest firmware update files are available on the Rohde & Schwarz product website:

https://www.rohde-schwarz.com/en/firmware/nrp_s_sn/

5.2.3 Preparation

1. Make sure a recent VISA software is installed. Firmware update with PureFW can only be performed with the device recognized as a VISA device.
2. Connect the power sensor to the PC using an NRP-ZKU interface cable. Shortly afterwards, the PC should have identified the new USB hardware.

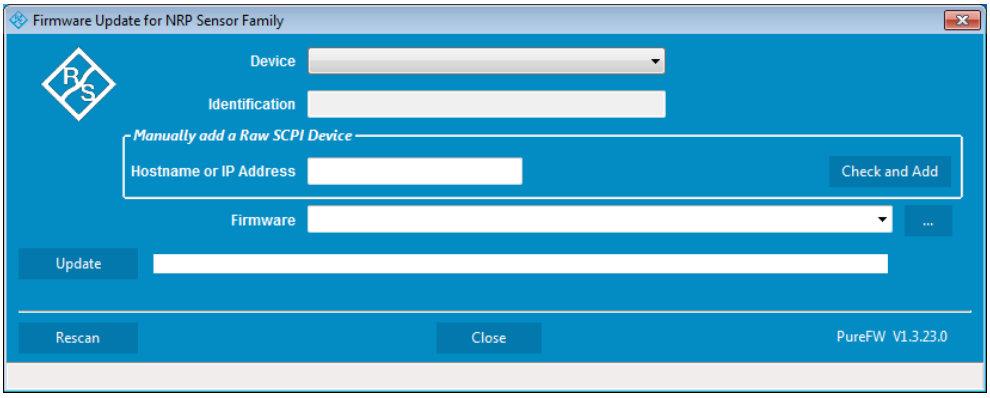
If no recent VISA software is installed, one of two possible things will happen:

1. *R&S NRP Toolkit is installed.*
   The driver assigned to the sensor will be the legacy driver. You will not find the sensor in the list of sensors provided by PureFW!
   ⇒ Install valid VISA software.
2. *R&S NRP Toolkit is not installed.*
   Windows will try in vain to find a USB driver for the power sensor. If this happens, the sensor is highlighted by a yellow exclamation mark in the Windows device manager.
   ⇒ Abort the installation process and install a recent VISA software.

5.2.4 Updating the Application Firmware

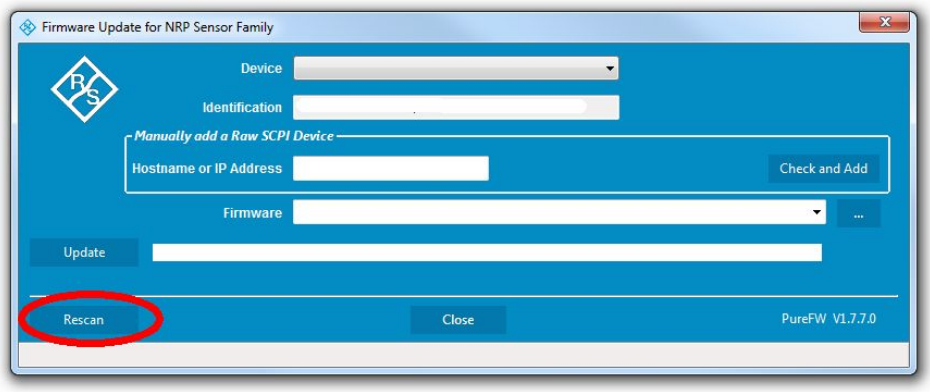
To perform a firmware update:

1. Start the Firmware Update program (PureFW) via "Start menu > NRP-Toolkit > Firmware Update". The following window should appear:



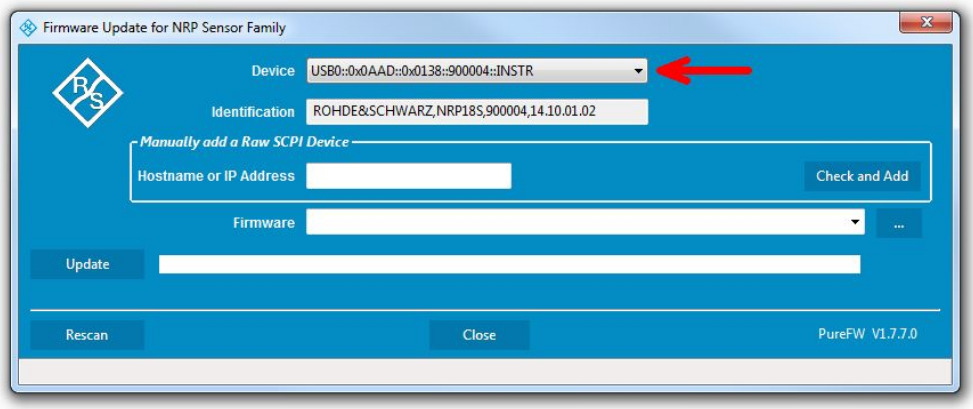
   The program automatically starts scanning for R&S NRP power sensors. When the scan is completed, all recognized power sensors are listed in the "Device" dropdown control.
2. If the sensor you want to update is not listed in the "Device" dropdown control, perform one of the following:

a) Press "Rescan" to search for attached sensors.



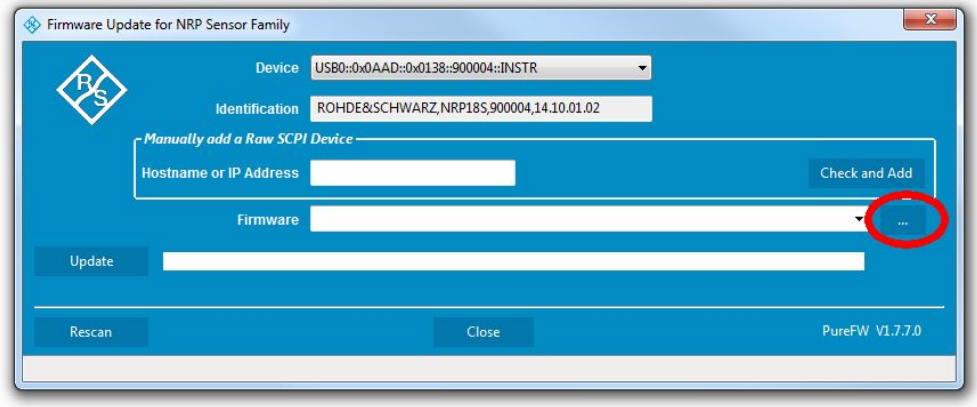
b) Check whether all necessary drivers are installed on the computer.
For example, if VISA library is not installed on the computer, no VISA power sensor will be accessible.

3. In the "Device" line select the sensor you want to update.

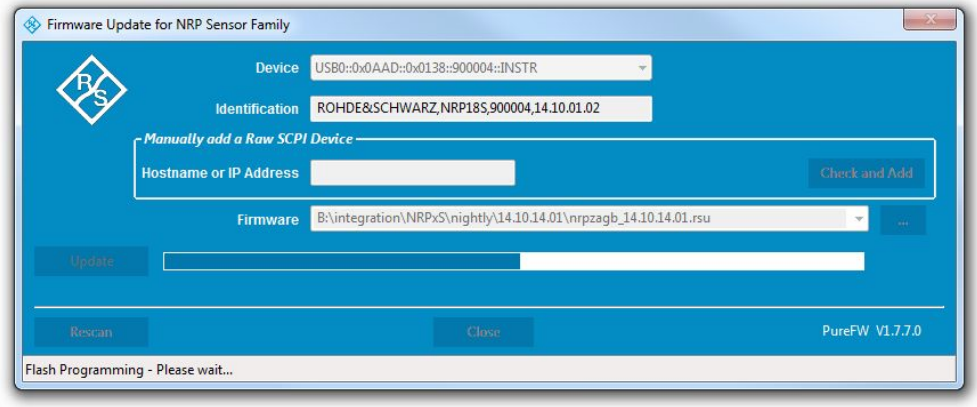


The "Hostname or IP Address" field is not used during this procedure and should therefore be left empty.

4. In the "Firmware" field enter the full path and file name of the update file or press the ellipsis button to browse the file system for it. New firmware for the R&S NRP power sensors generally has an `*.rsu` (Rohde & Schwarz Update) extension.

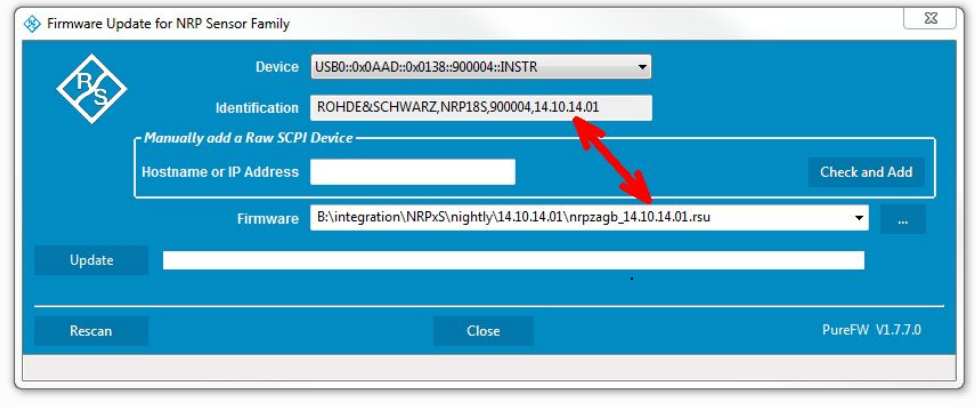


5. Click on the "Update" button to download the new firmware and program it into the flash memory of the sensor.



During the update process the progress is shown through a progress bar. The update sequence may take a couple of minutes, depending on the sensor model and the size of the selected file.

6. Check if the update was successful. This is the case if the firmware version in the "Identification" field is the same as the one you loaded in the "Firmware" field.



NOTICE

Potential damage to the firmware of the device

Disconnecting the power supply while an update is in progress may lead to missing or faulty firmware.

Special care must be taken on not disconnecting the power supply while the update is in progress. Interrupting the power supply during the firmware update will most likely lead to an unusable device which needs to be sent in for maintenance.

6 Remote Control Commands

6.1 Notations

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

For a detailed description of SCPI , see Chapter A, "Remote Control Basics", on page 135.

Numeric suffixes <n>

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

Optional keywords [ ]

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

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

Example:

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

```
SENSe:POWer:AVG:SMOothing:STATe 1
SENSe:POWer:SMOothing:STATe 1
SENSe:SMOothing:STATe 1
SMOothing:STATe 1
```

Parameters

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (,). For a description of the parameter types, refer to Chapter A.1.3, "SCPI Parameters", on page 137.

Example:

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

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

Special characters | and { }

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

6.2 Configuring the General Functions of the NRP Power Sensor

6.2.1 Common Commands

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

***CLS**

CLear Status

Resets the:

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

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

Usage: Event

***ESE** <register>

Event Status Enable

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

Parameters:

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

***ESR?**

Event Status Read query

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

Usage: Query only

***IDN?**

IDeNtification query

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

Usage: Query only

***IST?**

Individual STatus query

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

Usage: Query only

***OPC**

OPeration Complete

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

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

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

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

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

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

***OPT?**

OPTion identification query

Returns a comma separated list of installed options.

Usage: Query only

***PRE** <register>

Parallel poll Register Enable

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

Parameters:

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

***RCL** <number>

ReCaLl

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

Setting parameters:

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

Usage: Setting only

***RST**

ReSeT

Sets the sensor to the default state, i.e. the default settings for all parameters are loaded. The command corresponds to the command SYSTem:PRESet.

Usage: Event

***SAV** <number>

SAVe

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

Setting parameters:

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

Usage: Setting only

***SRE** <register>

Service Request Enable

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

Parameters:

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

***STB?**

STatus Byte query

Returns the contents of the status byte in decimal form.

Usage: Query only

***TRG**

TRiGger

Triggers a measurement. For this purpose, the sensor must be in the WAIT_FOR_TRIGGER state and the source of the trigger event must be set to `BUS` (`TRIGger:SOURce` on page 122 `BUS`).

Usage: Event

***TST?**

self TeST query

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

Usage: Query only

***WAI**

WAIt to continue

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

Usage: Event

6.2.2 Configuring the System

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

SYSTem:COMMunicate:NETWork:RESTart

Restarts the network connection to the instrument, i.e. terminates the connection and sets it up again.

Usage: Event

SYSTem:COMMunicate:NETWork:RESet

Resets the LAN network settings to the default values.

Usage: Event

SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Example:
```
SYST:COMM:NETW:STAT?
Response: UP
```
the network is active.

Usage: Query only

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

Sets the domain of the network.

Parameters:
<domain>

Example:
```
:SYST:COMM:NETW:COMM:DOM ABC.DE
```
Sets the domain of the network to `ABC.DE`.

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

Sets the individual host name of the power sensor.

In a LAN that uses a DNS server (Domain Name System server), each instrument connected in the LAN can be accessed via an unambiguous host name, instead of the IP address. The DNS server translates the host name to the IP address. This is especially useful when a DHCP server is used, as a new IP address may be assigned each time the instrument is restarted.

The sensor performs the change of the hostname immediately after the command is sent. For this purpose the sensor restarts its connection to the network. During this time that may take several seconds the sensor cannot be addressed. After the restart the sensor can be addressed only through the newly set hostname.

Note: It is recommended that you do not change the default host name in order to avoid problems with the network connection. However, if you change the host name be sure to use an unique name.

Parameters:
<hostname>

Example: `SYST:COMM:NETW:COMM:HOST 'powersensor-2nd-floor'`
Sets the hostname to `powersensor-2nd-floor`.

SYSTem:COMMunicate:NETWork:IPADdress <ipaddress>

Sets the IP address of the sensor, if `SYSTem:COMMunicate:NETWork:IPADdress:MODE` is set to `STATic`.

Parameters:
<ipaddress>

Example: `:SYST:COMM:NETW:IPAD '192.168.10.29'`
Sets the IP address of the sensor to `192.168.10.29`.

Manual operation: See "IP Address" on page 54

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

Sets the IP address of the default gateway, if `SYSTem:COMMunicate:NETWork:IPADdress:MODE` is set to `STATic`.

Parameters:
<gateway>

Example: `:SYST:COMM:NETW:IPAD:SUBN:GAT '192.168.10.254'`
Sets the IP address of the default gateway to `192.168.10.254`.

Manual operation: See "Gateway" on page 54

SYSTem:COMMunicate:NETWork:IPADdress:INFO?

Queries the network status information.

Usage: Query only

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

Selects if the IP address is assigned automatically or manually.

Parameters:

<mode> AUTO | STATic

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

STATic
Enables assigning the IP address manually.

*RST: AUTO

Example: `:SYST:COMM:NETW:IPAD:MODE AUTO`
The IP address is assigned automatically.

Manual operation: See "DHCP" on page 54

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

Sets the subnet mask, if `SYSTem:COMMunicate:NETWork:IPADdress:MODE` is set to `STATic`.

Parameters:

<netmask>

Example: `:SYST:COMM:NETW:IPAD:SUBN:MASK '255.255.255.0'`
Sets the subnet mask to `255.255.255.0`.

Manual operation: See "Subnet Mask" on page 54

SYSTem:CLOCk:SOURce <source>

Sets the clock source to internal or external reference.

Parameters:

<source> INTernal | EXTernal

*RST: INTernal

SYSTem:DFPRint?

Reads the footprint file of the sensor.

Usage: Query only

SYSTem:ERRor:ALL?

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

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

Usage: Query only

SYSTem:ERRor:CODE:ALL?

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

Example: `SYST:ERR:CODE:ALL?`
Queries all entries in the error queue.
`Response: 0`
No errors have occurred since the error queue was last read out.

Usage: Query only

SYSTem:ERRor:CODE[:NEXT]?

Queries the oldest entry in the error queue and then deletes it. Only the error number is returned and not the entire error text.

Example: `SYST:ERR:CODE`
Queries the oldest entry in the error queue.
`Response: 0`
No errors have occurred since the error queue was last read out.

Usage: Query only

SYSTem:ERRor:COUNt?

Queries the number of entries in the error queue.

Example: `SYST:ERR:COUN`
Queries the number of entries in the error queue.
`Response: 1`
One error has occurred since the error queue was last read out.

Usage: Query only

SYSTem:ERRor[:NEXT]?

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

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

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

Usage: Query only

SYSTem:FEATures? [<GrpNr>]

Queries a list of system features.

Query parameters:

<GrpNr> Range: 1 to 20

Usage: Query only

SYSTem:FWUPdate <fwudata>

This command is used to load new operating firmware into the device. Rohde & Schwarz provides new firmware in form of `*.rsu` files. An `*.rsu` file often can be downloaded from the R&S web sites or may be supplied by the customer support or the product marketing.

There are dedicated programs from Rohde & Schwarz for loading new firmware into a R&S NRPxxS[N] power sensor (for example, PureFW).

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

A Definite Length Datablock has a well defined format. It consists of a '#' sign, a single digit indicating the length of the number which represents the size of the binary file, followed by the binary data and an appended delimiter (LF, 0x0a).

Example:

If you want to put a new firmware into an R&S NRP18SN, you first need an update file, e.g. `nrp18sn_FW_15.02.12.01.rsu`.

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

First, have a look at the size of the binary data; this is 10242884 in our case. This number has 8 digits. Now you have all the information to assemble everything:

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

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

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

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

In a (pseudo) string notation this will be:

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

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

Setting parameters:
<fwudata> <block_data>

Usage: Setting only

SYSTem:FWUPdate:STATus?

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

The result of the query is a readable string.

Example: `SYST:FWUP:STAT?`
Response: `"Success"`

Usage: Query only

SYSTem:HELP:HEADers? [<Item>]

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

Query parameters:
<Item> <block_data>

Usage: Query only

SYSTem:HELP:SYNTax? [<Item>]

Returns the relevant parameter information for the specified SCPI.

Query parameters:
<Item>

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

Usage: Query only

SYSTem:HELP:SYNTax:ALL?

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

Usage: Query only

SYSTem:INFO? [<Item>]

Returns information about the system.

`SYSTem:INFO?<string_value>` is used to query a specific information item. If called without parameters, the command returns all available information in the form of a list of strings separated by commas.

`<string_value>` can have the following values:

- Manufacturer
- Type
- Stock Number
- Serial
- SW Build
- MAC Address
- Hostname
- IP Address
- Domain
- Subnetmask
- Gateway
- Mode
- Status
- Sensor Name
- Technology
- Function
- MinPower
- MaxPower
- MinFreq
- MaxFreq
- Resolution
- Impedance
- Coupling
- Cal. Misc.
- Cal. Abs.
- Cal. Refl.
- Cal. Temp.
- Cal. Lin.
- Cal. S-Para.
- Cal. S-Para. (User)
- SPD Mnemonic
- Cal. Due Date
- Certificate No
- TestLimit
- TestLimit pd
- Uptime

Query parameters:
<Item>

Usage: Query only

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.

Usage: Event

SYSTem:LANGuage <language>

Selects an emulation of a different command set.

Parameters:
<language> SCPI
*RST: SCPI

SYSTem:LED:COLor <color>

Sets the color of the system status LED after the operating mode of the LED has been set to `USER`.

Parameters:
<color> Range: 0x00 to 0x0FFFFFFF
*RST: 0xA0A0A0

Example: `SYST:LED:MODE user`
Sets the system status LED operating mode to user.

`SYST:LED:COL #HA000A0`
Sets the LED color to magenta.

`SYST:LED:COL #H00C000`
Sets the LED color to green.

`SYST:LED:MODE sensor`
Sets the system status LED operating mode back to the sensor internal settings.

SYSTem:LED:MODE <mode>

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

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

Parameters:
<mode> USER | SENSOR
*RST: SENSOR

SYSTem:LIMits? [<GrpNr>]

Queries the limits of the sensors parameters.

Query parameters:
<GrpNr> Range: 1 to 20

Usage: Query only

SYSTem:MINPower?

Yields the lower power measurement limit. This value may change if `[SENSe<Sensor>:]CORRection:SPDevice:STATe` is set to `ON`. The lower measurement limit may refer to the sensor or to the combination of a sensor and the components connected ahead of it.

This query can be used to determine a useful resolution for the result display near the lower measurement limit.

Usage: Query only

SYSTem:PRESet <preset>

Triggers a sensor reset.

The command essentially corresponds to the command `*RST` on page 74. Exceptions are the values of the commands `INITiate:CONTinuous`, `[SENSe<Sensor>:]AVERage:TCONtrol` and `[SENSe<Sensor>:]TRACe:AVERage:TCONtrol` , see `*RST` on page 74).

Parameters:
<preset> <block_data>

SYSTem:REBoot

Reboots the power sensor.

Usage: Event

SYSTem:SERRor?

Returns the next static error (if any). Static errors are generally more severe than normal error conditions, which can be queried with `SYSTem:ERRor[:NEXT]?`. While normal errors result from, for example, unknown commands or syntax errors and generally affect a single parameter or setting, the static errors, as a rule, prevent the execution of normal measurements.

Static errors occur when a user selects conflicting settings. This could, for example, occur in Timeslot measurement mode when a user sets the width of a timeslot to 100 µs, and then sets an exclude time at the start of the slot to 40 µs and an end exclude time to 60 µs. Then there is "nothing left" to be measured and a static error appears.

Usage: Query only

SYSTem:SERRor:LIST:ALL?

Returns a list of all static errors that have occurred but have already been resolved. This can be for example an overload of a short duration.

Example: `SYST:SERR:LIST:ALL?`
Response: `0,"reported at uptime:2942; notice; auto-averaging exceeded maximum time; Notification",0,"removed at uptime:2944; notice; auto-averaging exceeded maximum time; Notification"`

Usage: Query only

SYSTem:SERRor:LIST:[NEXT]?

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

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

Usage: Query only

SYSTem:TLEVels?

Queries the possible power test levels of the sensor.

Usage: Query only

SYSTem:TRANsaction:BEGin

Starts a series of settings.

Usage: Event

SYSTem:TRANsaction:END

Ends a series of settings.

Usage: Event

SYSTem[:SENSor]:NAME <sensorname>

Sets a name of the sensors according to the users requirements. The name specified by "new-name" will be displayed on the WebGUI of the network sensors.

The sensor name given here is independent from the hostname of the sensor. However, if the sensor name is not yet specified it defaults to the hostname.

Example:

```
SYSTem:SENSe:NAME "InputModule-X5"
```

results in a display as shown in Figure 6-1.

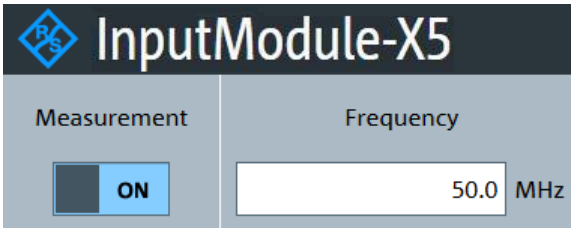


Figure 6-1: Sensor Name

Parameters:
<sensorname>

Manual operation: See "Sensor Name" on page 54

SYSTem:VERSion?

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

Example: `SYST:VERS?`
Queries the SCPI version.
Response: `1999.0`
The sensor complies with the SCPI version from 1999.

Usage: Query only

6.2.3 Selecting a Measurement Path

The `RANGe` subsystem contains command for selection of a measurement path.

[SENSe<Sensor>:]RANGe <range>

Selects manually the active measurement path.

Parameters:

<range>	Range:	0 to 2
	*RST:	2

[SENSe<Sensor>:]RANGe:AUTO <state>

Enables automatic measurement path selection.

Parameters:

<state>	*RST:	ON

[SENSe<Sensor>:]RANGe:CLEVel <level>

Shifts the transition point between paths downward.

Parameters:

<level>	Range:	-20.00 to 0.00
	*RST:	0.00

6.2.4 Setting the Power Unit

The `UNIT` subsystem contains command for setting up the power unit.

UNIT:POWer <unit>

Sets the output unit for the measured power values.

Parameters:

<unit>	DBM | W | DBUV	
	*RST:	W

6.2.5 Setting the Result Format

The `FORMat` subsystem sets the format of numeric data (measured values) that is exchanged between the remote control computer and the power sensors if high-level measurement commands are used.

FORMat:BORDer <border>

Influences the order of bytes in 64-bit binary data.

Parameters:

<border> NORMal | SWAPped

NORMal
The 1st byte is the MSB (most significant byte), the 8th byte the LSB (least significant byte).
This fulfills the Big Endian convention (Big Endian: "the big end comes first").

SWAPped
SWAPped The 1st byte is the LSB (least significant byte), the 8th byte the MSB (most significant byte).
This fulfills the Little Endian convention.

*RST: NORMAL

FORMat:SREGister <sregister>

Specifies which format is used for the return value of `*STB`.

Parameters:

<sregister> ASCii | HEXadecimal | OCTal | BINary

*RST: ASCII

FORMat[:DATA] <data>

Specifies whether numeric data is sent as block data in binary form (`REAL`) or as character strings in plain text (`ASCII`).

Parameters:

<data> ASCii | REAL

*RST: ASCII

6.3 Selecting a Measurement Mode and Retrieving Results

Before starting a measurement the measurement mode has to be selected with `[SENSe<Sensor>:]FUNCtion`.

The following modes are available:

- Continuous average (`"POWer:AVG"`): After a trigger event, the power is integrated over a time interval.
  See also Chapter 6.4.1, "Configuring a Continuous Average Measurement", on page 94.
- Burst average (`"POWer:BURSt:AVG"`): The integration time of a measurement is not predefined but determined by the sensor with the aid of a burst detector. The start of a burst is detected when the measurement signal rises above a set trigger level. The measurement ends when the signal drops below a trigger threshold.

See also Chapter 6.4.2, "Configuring a Burst Average Measurement", on page 96.

- Timeslot average (`"POWer:TSLot:AVG"`): The power is simultaneously measured in up to 32 time slots. The measurement result is represented by a vector that can contain up to 32 indices and contains the power of a time slots at each index.
  See also Chapter 6.4.3, "Configuring a Timeslot Average Measurement", on page 98.
- Trace (`"XTIMe:POWer"`): A sequence of measurements is performed.
  See also Chapter 6.4.4, "Configuring a Trace Measurement", on page 101.

After performing the measurement, you can query the measurement results with the correspondent `FETCh` command.

Programming Example

```
*RST                              // resets the sensor
SENS:FUNC "POW:AVG"               // selects continuous average mode
INIT                              // initiates the measurement
FETC?                             // queries the measurement result
```

[SENSe<Sensor>:]FUNCtion <function>

Sets the measurement mode.

Parameters:

<function>

"POWer:AVG"
Continuous Average
After a trigger event, the power is integrated over a time interval (averaging) set with `[SENSe<Sensor>:][POWer:][AVG:]APERture`.

"POWer:BURSt:AVG"
Burst
In remote control, this measurement mode is very similar to the ContAv mode. The integration time is, however, not predefined but determined by the sensor with the aid of a burst detector. The start of a burst is detected when the measurement signal rises above the set trigger level. The end is set when the signal drops below the trigger threshold.
`[SENSe<Sensor>:][POWer:]BURSt:DTOLerance` defines the time interval during which the signal level must be below the trigger level so that the end of the burst can be detected. In the Burst mode, the set trigger source is ignored and `TRIGger:SOURce` on page 122`INT` is implicitly assumed.

"POWer:TSLot:AVG"
Timeslot
The power is simultaneously measured in up to 32 time windows.
The number of time windows is set with `[SENSe<Sensor>:][POWer:]TSLot[:AVG]:COUNt`.
The length of a time window is determined via `[SENSe<Sensor>:][POWer:]TSLot[:AVG]:WIDTh`. The measurement result is represented by a vector that can contain up to 32 indices and contains the power of a time window at each index.

"XTIMe:POWer"
Trace
In this mode, power over time is measured. Therefore a number of measurement points are defined (`[SENSe<Sensor>:]TRACe:POINts`) where the length of an individual measurement is determined from the ratio of total time (`[SENSe<Sensor>:]TRACe:TIME`) and the defined number of measurement points.

*RST: "POWer:AVG"

FETCh?

Queries the last valid measurement result.

FETCh<Sensor>:ARRay[:POWer][:AVG]?

Queries the last valid measurement result of a measurement with enabled data buffer mode.

Usage: Query only

CALCulate:FEED <mode>

When measurement data is requested from the sensor by means of the `FETCh?` command the sensor returns data of a measurand which was configured before. By default this is generally the Average power. However the sensor can also output data of different measurands.

In order to configure which measurand the `FETCH?` command will send, the `CALC:FEED` command needs to be used before a measurement is initiated. Depending on the measurement mode the following settings are possible:

SENS:FUNC	Possible CALC:FEED	Meaning
`"POWer:AVG"`	`"POWer:AVERage"`	Average value
	`"POWer:PEAK"`	Peak value
	`"POWer:RANDom"`	Randomly selected value from the measurement interval
`"POWer:BURSt:AVG"`	`"POWer:AVERage"`	Average value
	`"POWer:PEAK"`	Peak value
	`"POWer:RANDom"`	Randomly selected value from the measurement interval
`"POWer:TSLot:AVG"`	`"POWer:AVERage"`	Average value
	`"POWer:PEAK"`	Peak value
	`"POWer:RANDom"`	Randomly selected value from the measurement interval
`"XTIMe:POWer"`	`"POWer:TRACe"`	Measurement sequence
	`"POWer:PEAK:TRACe"`	Peak value of the samples per trace point
	`"POWer:RANDom:TRACe"`	Randomly selected value of the samples per trace point

Parameters:
<mode> *RST: "POWer:AVERage"

Example: The following sequence of commands configures a Peak Trace measurement

```
*RST
SENS:FUNC "XTIM:POW"
SENS:FREQ 1.0e9
SENS:TRAC:POIN 500
SENS:TRAC:TIME 20e-3
TRIG:SOUR INT
TRIG:SLOP POS
TRIG:DTIM 0.001
TRIG:HYST 0.1
TRIG:LEV 30e-6
SENS:TRAC:AVER:COUN 8
SENS:TRAC:AVER:STAT ON
CALC:FEED "POW:PEAK:TRAC"
INIT
FETCH?
```

[SENSe<Sensor>:]AUXiliary <mode>

Activates the measurement of additional measured values that are determined together with the main measured value.

Parameters:

<mode> NONE | MINMax | RNDMax

NONE
No additional values are measured.

MINMax
By averaging the measured values in the sensor, extreme values are lost.
Using `MINMax` a sensor can be assigned to transmit the minima and maxima that occurred in the Trace mode together with the measured value.

RNDMax
In contrast to `MINMax`, instead of the Min value the value of a randomly selected sample is returned. All evaluations occur using these values instead of the average values.

*RST: NONE

6.4 Configuring the Measurement Modes

In the following chapter the settings needed for configuring a measurement mode are described.

6.4.1 Configuring a Continuous Average Measurement

The Continuous Average mode measures the signal average power asynchronously within definable time intervals (sampling windows). The aperture (width of the sampling windows) can be defined.

Reducing noise and zero offset

The continuous average measurement can be performed with chopper stabilization to obtain more accurate results with reduced noise and zero offset. When chopper stabilization is used a single measurement is performed over two sampling windows, the polarity of the detector output signal being reversed for the second window. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized.

The smoothing filter can further reduce result fluctuations caused by modulation. But when activated it increases the inherent noise of the sensor by approx. 20%, so it should remain deactivated if it is not required.

Configuring continuous average measurements of modulated signals

When performing continuous average measurements of modulated signals the measurement may show fluctuation due to the modulation. In this case it is 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.

With smoothing activated, the selected sampling window has to be 5 to 9 times larger than the modulation period for the fluctuations caused by modulation to be sufficiently reduced.

As a comparison, if you deactivate the smoothing filter 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 behavior of the measuring instrument. Optimum suppression of variations in the result is 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 behavior 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.

Programming Example

```
*RST                            // resets the sensor
SENS:FUNC "POW:AVG"             // selcts continuous average mode
SENS:POW:AVG:APER 0.01          // sets the aperture time to 10 ms
SENS:POW:AVG:SMO:STAT ON        // enables smoothing
```

```
INIT                              // initiates the measurement
FETC?                             // queries the measurement result
```


[SENSe<Sensor>:][POWer:][AVG:]APERture <integration_time>

Sets the aperture, sampling window (time interval) for the continuos average mode. Defines the length of the unsynchronized time interval used to measure the average signal power.

Parameters:

<integration_time> Range: 10.0e-6 to 2.00
*RST: 0.02

Manual operation: See "Aperture Time" on page 43

[SENSe<Sensor>:][POWer:][AVG:]BUFFer:CLEar

Clears the contents of the continuous average result buffer.

Usage: Event

[SENSe<Sensor>:][POWer:][AVG:]BUFFer:COUNt?

Queries the number of results that is currently stored in the continuous average result buffer.

Usage: Query only

[SENSe<Sensor>:][POWer:][AVG:]BUFFer:DATA?

Queries the results of the continuous average result buffer and returns them even if the buffer is not full.

In contrast the `FETCh?` command returns a result only if the buffer is full.

Usage: Query only

[SENSe<Sensor>:][POWer:][AVG:]BUFFer:SIZE <count>

Sets the buffer size for the buffered continuous average mode. This modes is activated with `[SENSe<Sensor>:][POWer:][AVG:]BUFFer:STATe`.

Parameters:

<count>	Range:	1 to 8192
	*RST:	1

[SENSe<Sensor>:][POWer:][AVG:]BUFFer:STATe <state>

Activates/deactivates the buffered continuous average mode. When the buffer mode is activated, all results generated by trigger events are collected in the sensor until the buffer is filled.

You can set the size of the buffer with `[SENSe<Sensor>:][POWer:][AVG:]BUFFer:SIZE`.

Parameters:

<state>	*RST:	OFF

[SENSe<Sensor>:][POWer:][AVG:]FAST <state>

Enables a fast unchopped Continuous Average measurement.

Parameters:

<state>	*RST:	OFF

Example: See Chapter 7, "Performing Measurement Tasks - Programming Examples", on page 130.

[SENSe<Sensor>:][POWer:][AVG:]SMOothing:STATe <state>

Activates/deactivates the smoothing filter, a steep-edge digital lowpass filter. The filter reduces result fluctuations caused by modulation, if the aperture time cannot be exactly adjusted to the modulation period.

Parameters:

<state>	*RST:	OFF

Manual operation: See "Smoothing" on page 44

6.4.2 Configuring a Burst Average Measurement

The Burst Average mode is used to measure the average power of bursts. The time interval in which the average power is measured starts when the power exceeds the trigger level and stops when the trigger logic detects the end of the pulse.

Fig. 6-2 shows a graphical representation of a burst average measurement and the meaning of the parameters that can be configured.

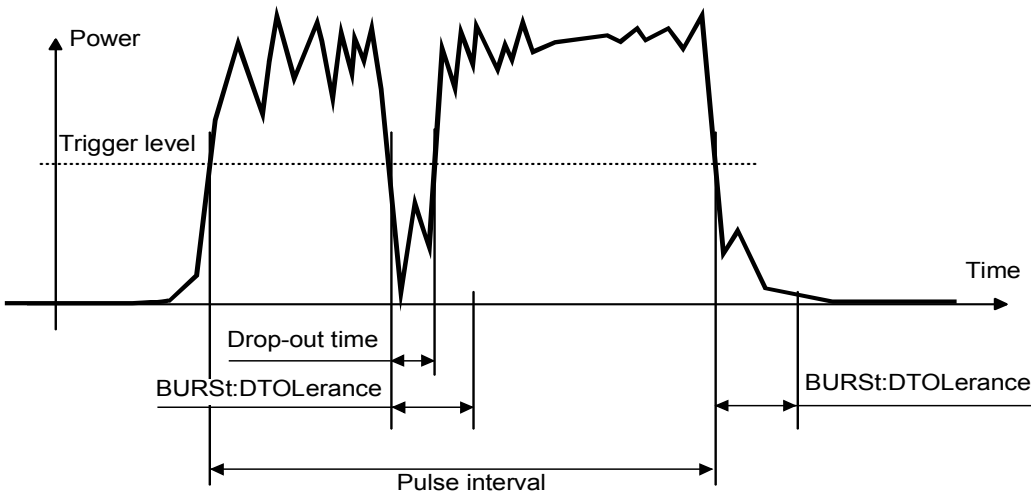


Figure 6-2: Burst average measurement parameters

To prevent power drops due to modulation from being erroneously interpreted as the end of a pulse, you must define the dropout tolerance. This is a time interval in which the pulse end is only recognized if the signal level no longer exceeds the trigger level.

Reducing noise and zero offset

The burst measurement can be performed with chopper stabilization to obtain more accurate results with reduced noise and zero offset. Chopper stabilization involves that the polarity of the detector output signal is reversed from burst to burst. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized.

Triggering a burst average measurement

In the burst average mode, only internal trigger events from the signal are evaluated, irrespective of the setting of the `TRIGger:SOURce` parameter. The `TRIGger:DELay` parameter is also ignored, so that the measurement interval begins exactly when the signal exceeds the trigger level.

Defining a time interval for the measurement

Time intervals that are to be excluded from the measurement can be set at the beginning and at the end of the measurement interval with the commands `[SENSe<Sensor>:]TIMing:EXCLude:STARt` and `[SENSe<Sensor>:]TIMing:EXCLude:STOP` on page 110, see Chapter 6.5.3, "Setting Exclusion Time", on page 110.

Programming Example

```
*RST                              // resets the sensor
SENS:FUNC "POW:BURS"              // selcts burst average mode
SENSe:POW:BURS DTOL 0.1           // sets the dropout tolerance
```

```
INIT                              // initiates the measurement
FETC?                             // queries the measurement result
```


[SENSe<Sensor>:][POWer:]BURSt:DTOLerance <tolerance>

Sets the drop-out tolerance, a time interval in which the pulse end is only recognized if the signal level no longer exceeds the trigger level (see Figure 6-2).

Parameters:

<tolerance> Range: 0.00 to 0.30
*RST: 1.000e-6

Manual operation: See "Dropout Tolerance" on page 45

[SENSe<Sensor>:][POWer:]BURSt:CHOPper:STATe [<arg0>]

Activates/deactivates the chopper stabilization for the burst average mode.

Suffix:

<Sensor> 1

Parameters:

<arg0>

[SENSe<Sensor>:][POWer:]BURSt:LENGth?

Queries the length of a burst (pulse interval), the time between the trigger point of the measurement and the time the trigger logic detects the end of the pulse (see Figure 6-2).

Usage: Query only

6.4.3 Configuring a Timeslot Average Measurement

The Timeslot Average mode is used to measure the average power of a definable number of successive timeslots within a frame structure with equal spacing. The measurement result is an array with the same number of elements as timeslots. Each element represents the average power in a particular timeslot.

Fig.6-3 shows a graphical representation of a timeslot average measurement and the meaning of the parameters that can be configured.

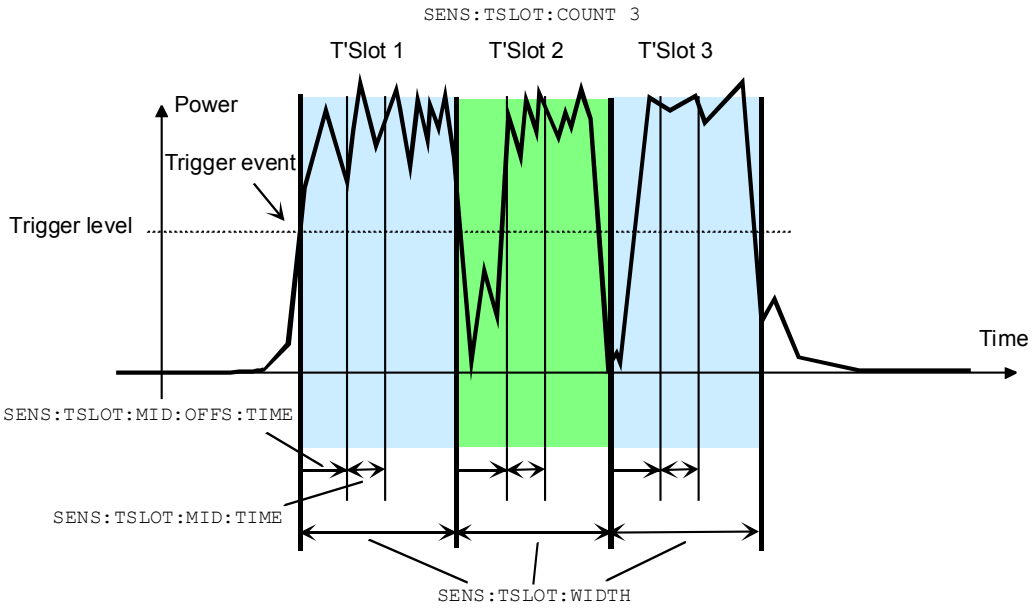


Figure 6-3: Timeslot parameters

Reducing noise and zero offset

The timeslot measurement can be performed with chopper stabilization to obtain more accurate results with reduced noise and zero offset. Chopper stabilization involves that the polarity of the detector output signal is reversed from frame to frame. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized.

Triggering a timeslot average measurement

In the timeslot mode, internal and external trigger events from the signal are evaluated depending on the settings of the `TRIGger:SOURce` parameter. It is essential to define the `TRIGger:DELay` parameter to ensure that the beginning of the first slot to be measured coincides with the delayed trigger point.

Defining a time interval for the measurement

Additionally, time intervals that are to be excluded from the measurement can be set at the beginning and at the end of the measurement interval, with the commands `[SENSe<Sensor>:]TIMing:EXCLude:STARt` and `[SENSe<Sensor>:]TIMing:EXCLude:STOP` on page 110, see Chapter 6.5.3, "Setting Exclusion Time", on page 110.

[SENSe<Sensor>:][POWer:]TSLot[:AVG]:COUNt <count>

Sets the number of simultaneously measured timeslots in the timeslot mode (see Figure 6-3).

Parameters:

<count> Range: 1 to 32
*RST: 8

Manual operation: See "Number of timeslots" on page 45

[SENSe<Sensor>:][POWer:]TSLot[:AVG]:WIDTh <width>

Sets the length of the timeslot (see Figure 6-3).

Parameters:

<width> Range: 10.0e-6 to 0.10
*RST: 1.000e-3

Manual operation: See "Nominal Width" on page 45

[SENSe<Sensor>:][POWer:]TSLot[:AVG][:EXCLude]:MID:OFFSet[:TIME] <time>

Determines the distance from the start of the timeslots to the start of the interval to be blanked out (see Figure 6-3).

Parameters:

<time> Range: 0.00 to 0.10
*RST: 0.00

[SENSe<Sensor>:][POWer:]TSLot[:AVG][:EXCLude]:MID:TIME <time>

Sets the length of the time interval in the timeslots to be excluded from the measurement (see Figure 6-3). The parameter applies to each individual timeslot.

Note: Even if the exclusion interval exceeds the timeslot because, for example, its right limit is outside the timeslot, correct results are obtained. In the extreme case, where the interval length has been set to a value greater than the timeslot length, 0 W is output as the measured power. No error message is output.

Parameters:

<time> Range: 0.00 to 0.10
*RST: 0.00

[SENSe<Sensor>:][POWer:]TSLot[:AVG][:EXCLude]:MID[:STATe] <state>

Activates / deactivates the blanking out of time intervals in the timeslots.

Parameters:

<state> *RST: OFF

6.4.4 Configuring a Trace Measurement

The trace measurement is used to acquire the course of power over a certain time. During the measurement time (`[SENSe<Sensor>:]TRACe:TIME`) a large number of measurements are made and the result is returned to the user as an array of values with a predefined size `[SENSe<Sensor>:]TRACe:POINts`. The length of an individual measurement(-point) is determined from the ratio of measurement time and measurement points. The entire result is called a "trace". Each trace must be triggered separately.

[SENSe<Sensor>:]TRACe:AVERage:COUNt <count>

Sets the filter length, the number of readings to be averaged for one measured value, for the Trace mode. The higher the count the lower the noise and the longer it takes to obtain a measured value.

Parameters:

<count>	Range:	1 to 65536
	*RST:	4

[SENSe<Sensor>:]TRACe:AVERage:TCONtrol <mode>

Sets the terminal control mode for the Trace mode, defining how the measurement results are output.

As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output. It is obtained from the new measured value and the other values stored in the filter.

Parameters:

<mode> MOVing | REPeat

MOVing
Each new average value is output as a measurement result.
This mode is suitable for measurements, where tendencies in the result have to be recognized during the measurement procedure.

REPeat
A new result is output after the FIR filter has been filled with new measured values.
This mode is suitable for measurements, where no redundant information has to be output.

*RST: REPeat

[SENSe<Sensor>:]TRACe:AVERage[:STATe] <state>

Switches the averaging filter on and off for the Trace mode.

Parameters:

<state> *RST: ON

[SENSe<Sensor>:]TRACe:DATA?

Returns the measured trace data in a well defined format. Unlike the `FETCh?` command, `[SENSe<Sensor>:]TRACe:DATA` takes the settings of `[SENSe<Sensor>:]AUXiliary` into account. This is explained in greater details below.

Command Response

To describe the format of the command response it is important to know a few additional informations.

Besides the Average power the sensor can measure additional measurands like Minimum, Maximum or Random. These additional measurands are generally denoted as auxiliary measurands and can be selected through the `[SENSe<Sensor>:]AUXiliary` command.

A trace measurement can be configured to deliver up to three measurands. Therefore the resulting block of data which is provided by a `[SENSe<Sensor>:]TRACe:DATA` query can contain 1 to 3 blocks of User Data.

Basically the `[SENSe<Sensor>:]TRACe:DATA` response represents a Definite Length Arbitrary Block Response Data as defined in IEEE488.2. This object consistis of a header and some content.

In principle the response has the format as shown in Figure 6-4:

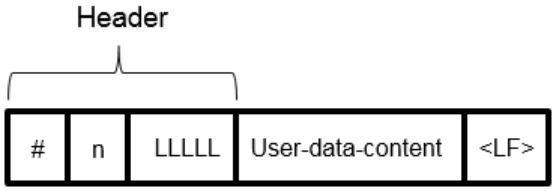


Figure 6-4: Response format

- header consisting of:
  - the character #
  - a single digit ('n') which tells the number of following digits that shall be taken as the size of the content.
  - a number consisting of as many digit as 'n' specified ('LLLLL'). This number gives the size of the content
- the content ('user-data-content'), see also Figure 6-5. These are as many bytes as 'LLLLL' specified
- a single linefeed character (symbolically shown as <LF>, Response format)

Example:

The Arbitrary Block Response Data for a user data that contains 45182 bytes would be:

```
#545182xxxxxx.......xxxxxx <LF>
```

The Arbitrary Block Response Data for a user-data-content `'THIS IS A TEST'` would be:

```
#214THIS IS A TEST<LF>
```

Explanation: `'THIS IS A TEST'` has 14 bytes, and '14' has 2 digits, hence the `#214`

User-data-content

The previous paragraphs described how to separate the "user-data-content" from the header. We keep the designator "user-data-content" in the further description for denoting the totality of the contained measurement results.

The further description deals with the user-data-content and shows what is embedded in it. There are similar mechanism as with Arbitrary Block Response Data in the user-data-content. As indicated above, the user-data-content can have 1 or more sections with Trace measurement results, depending on the selection of auxiliary measurands. Each section is composed of:

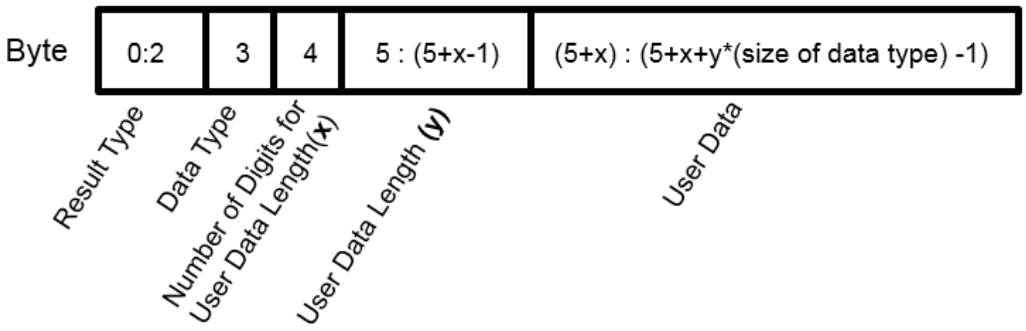


Figure 6-5: User-data-content format

y = number of values which follow the header
x = number of digits of y

- a result type (always 3 bytes, one of 'AVG', 'MIN', 'MAX' or 'RND')
- a designator for the contained data type with the size of 1 byte
  Currently the only possible designator is 'f' for 4-byte IEEE754 Float data type, Little Endian
- a single digit which tells the number of following digits that shall be taken as the number of contained float values
- as many digits as the number of digits for user data specified ('x'). These digits shall be interpreted as the number of values ('y') (not number of bytes) which follow the header
- the measurement result values in the format which is described by the data type (currently IEEE754 Float only)

If no `[SENSe<Sensor>:]AUXiliary` measurands have been activated before executing the measurement, the user-data-content is finished here. In case that auxiliary measurands have been selected, the above section will be repeated for every auxiliary measurand. The user-data-content will look like

```
AVGf3100...(400byte AVG values)...MINf3100...(400byte min.
values)...MAXf3100...(400byte max. values)...
```

where each of

```
...(400byte AVG values)...
```

```
...(400byte min. values)...
```

```
...(400byte max. values)...
```

stands for 400 bytes as the equivalent of 100 float values.

Keep in mind that this is only the user-data-content. This is embedded in the Arbitrary Block Response Data response of the `[SENSe<Sensor>:]TRACe:DATA` query.

Usage: Query only

[SENSe<Sensor>:]TRACe:MPWidth?

Queries the attainable time resolution for the Trace mode. The result is the smallest possible distance between two pixels, i.e. it is the smallest time interval that can be assigned to a pixel.

Usage: Query only

[SENSe<Sensor>:]TRACe:OFFSet:TIME <time>

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

The start of recording is referenced to the delayed trigger point that is set with `TRIGger:DELay`. Negative values indicate that the start of recording occurs before the trigger point.

Parameters:

<time> Range: - (500 ms + TRGger:DELay) to 100 s
*RST: 0.0

Manual operation: See "Trace Offset Time" on page 47

[SENSe<Sensor>:]TRACe:POINts <points>

Sets the number of required values per trace sequence.

Parameters:

<points> Range: 1 to 8192
*RST: 260

Manual operation: See "Trace Points" on page 47

[SENSe<Sensor>:]TRACe:REALtime <state>

Activates realtime processing for the Trace mode.

In the default state (`OFF`), each measurement from the sensor is averaged. With `[SENSe:]TRACe::REALtime ON`, this behavior is switched off and only one sampling sequence per measurement is recorded. This may increase the measurement speed. With a higher measurement speed the measured values of an individual measurement are immediately delivered.

The averaging filter is not used, so the settings made with `[SENSe<Sensor>:]TRACe:AVERage[:STATe]` and `[SENSe<Sensor>:]TRACe:AVERage:COUNt` are ignored.

Parameters:

<state> *RST: OFF

[SENSe<Sensor>:]TRACe:TIME <time>

Sets the trace length, time to be covered by the trace sequence. This time period is divided into a number of equal intervals, in which the average power is determined. The number of intervals equals the number of trace points, which is set with the command `[SENSe<Sensor>:]TRACe:POINts`.

Parameters:

<time> Range: 10.0e-6 to 3.0
*RST: 0.01

Manual operation: See "Trace Time" on page 47

6.5 Configuring Basic Measurement Parameters

In the following chapter settings common for several measurement modes are described.

6.5.1 Configuring Auto Averaging

This chapter includes the commands referring to automatic averaging for measurements in the continuous average, burst average and timeslot average modes.

[SENSe<Sensor>:]AVERage:COUNt <count>

Sets the filter length i.e. the number of readings to be averaged for one measured value. The higher the count the lower the noise and the longer it takes to obtain a measured value.

Parameters:

<count> Range: 1 to 65536
*RST: 4

[SENSe<Sensor>:]AVERage:COUNt:AUTO <state>

Sets the mode for determining the average count. Average count is often also called averaging factor, but it designates the same thing, i.e the number of measured values that have to be averaged for forming the measurement result.

Parameters:

<state>

ON
Auto averaging: the averaging factor is continuously determined and set depending on the level of power and other parameters.

OFF
Fixed filter: the previous, automatically determined averaging factor is used.

ONCE
An averaging factor is determined by the filter automatic function under the current measurement conditions and is then used in the fixed filter mode.

*RST: ON

[SENSe<Sensor>:]AVERage:COUNt:AUTO:MTIMe <maximum_time>

Sets an upper limit for the settling time of the auto-averaging filter if `[SENSe<Sensor>:]AVERage:COUNt:AUTO:TYPE` is set to `NSRatio`. Thus it limits the length of the filter.

Parameters:

<maximum_time>

Range: 0.01 to 999.99
*RST: 4.00

Manual operation: See "Auto Measurement Time" on page 51

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

Sets the maximum noise ratio in the measurement result.

This value is only taken into account for the Auto Averaging calculation when `[SENSe<Sensor>:]AVERage:COUNt:AUTO ON` and `[SENSe<Sensor>:]AVERage:COUNt:AUTO:TYPE NSR` are set.

Parameters:

<nsr>

Range: 100.000e-6 to 1.00
*RST: 0.01

[SENSe<Sensor>:]AVERage:COUNt:AUTO:RESolution <resolution>

Defines the number of significant places for linear units and the number of decimal places for logarithmic units which should be free of noise in the measurement result.

The setting is only taken into account, if `[SENSe<Sensor>:]AVERage:COUNt:AUTO ON` and `[SENSe<Sensor>:]AVERage:COUNt:AUTO:TYPE RES` are set.

Parameters:

<resolution> Range: 1 to 4
*RST: 3

[SENSe<Sensor>:]AVERage:COUNt:AUTO:SLOT <slot>

Available only if `[SENSe<Sensor>:]FUNCtion` is set to `POWer:TSLot:AVG`.

Sets a timeslot whose measured value is used to automatically determine the filter length. The timeslot number must not exceed the number of the currently set timeslots.

Parameters:

<slot> Range: 1 to 32
*RST: 1

[SENSe<Sensor>:]AVERage:RESet

Initializes the averaging filter. This is useful if a high averaging factor is set in the `[SENSe<Sensor>:]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<Sensor>:]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 set with `[SENSe<Sensor>:]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.

Usage: Event

[SENSe<Sensor>:]AVERage:COUNt:AUTO:TYPE <type>

Sets the automatic averaging filter mode.

Parameters:

<type> RESolution | NSRatio

RESolution
The usual mode for the power sensors.

NSRatio
Predefines the compliance to an exactly defined noise component.

*RST: RESolution

[SENSe<Sensor>:]AVERage:TCONtrol <mode>

Sets the terminal control mode, defining how the measurement results are output.

As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output. It is obtained from the new measured value and the other values stored in the filter.

Parameters:

<mode> MOVing | REPeat

MOVing
Each new average value is output as a measurement result.
This mode is suitable for measurements, where tendencies in the result have to be recognized during the measurement procedure.

REPeat
A new result is output after the FIR filter has been filled with new measured values.
This mode is suitable for measurements, where no redundant information has to be output.

*RST: REPeat

Manual operation: See "Filter Terminal Control" on page 51

[SENSe<Sensor>:]AVERage[:STATe] <state>

Switches the averaging filter on and off for the Continuous Average, Burst Average and Timeslot Average modes .

Parameters:

<state> *RST: ON

6.5.2 Setting the Frequency

The frequency of the signal to be measured is not automatically determined. For achieving better accuracy, the carrier frequency of the applied signal must be set.

[SENSe<Sensor>:]FREQuency <frequency>

Transfers the carrier frequency of the RF signal to be measured. This frequency is used for the frequency-response correction of the measurement result.

The center frequency is set for broadband signals, e.g. spread-spectrum signals, multicarrier signals.

Parameters:

<frequency> Range: 0.0 to 110.0e9
*RST: 1.0e9

Manual operation: See "Frequency" on page 42

6.5.3 Setting Exclusion Time

In the burst average and the timeslot average modes, you can define a time period at the beginning (`[SENSe<Sensor>:]TIMing:EXCLude:STARt`) or at the end (`[SENSe<Sensor>:]TIMing:EXCLude:STOP`) of an integration period, which is excluded from the measurement result, see Figure 6-6.

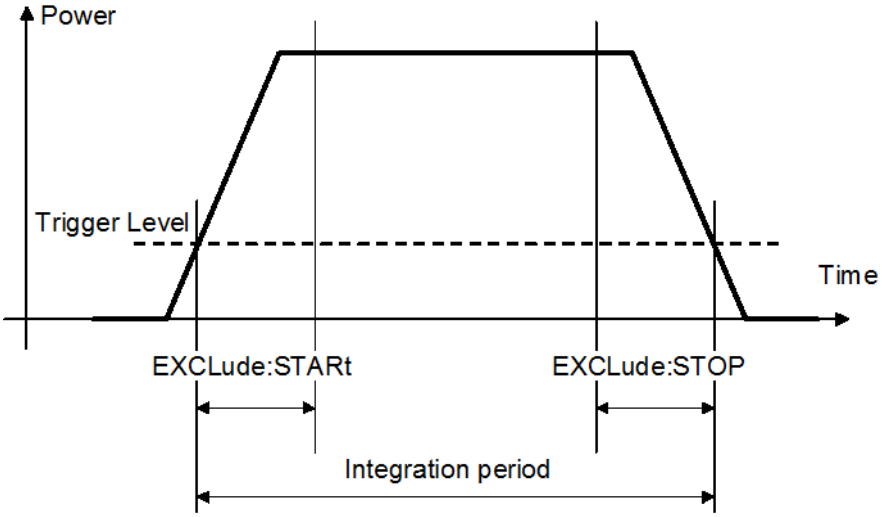


Figure 6-6: Effect of commands SENS:TIM:EXCL:STAR and :STOP

[SENSe<Sensor>:]TIMing:EXCLude:STARt <exclude_start>

Sets a time that is to be excluded at the beginning of the integration period, see Figure 6-6.

Parameters:

<exclude_start> Range: 0.0 to 1.0
*RST: 0.0

Manual operation: See "Start Exclude" on page 44
See "Start Exclude" on page 46

[SENSe<Sensor>:]TIMing:EXCLude:STOP <exclude_stop>

Sets a time that is to be excluded at the end of the integration period, see Figure 6-6.

Parameters:

<exclude_stop> Range: 0.0 to 1.0
*RST: 0.0

Manual operation: See "End Exclude" on page 44
See "End Exclude" on page 46

6.5.4 Configuring Corrections

It is possible to set some parameters that compensate for a change of the measured signal due to fixed external influences.

Corrections of the following parameters are available:

- Duty cycle: sets the duty cycle, the percentage of one period during which the signal is active, when pulse-modulated signals are corrected. The duty cycle is only evaluated in the Continuous Average mode.
- Offset: accounts for external losses by adding a fixed level offset in dB.
  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 the directional coupler. A negative offset can be used to correct the influence of an amplifier connected ahead.
- S-Parameters: used to compensate for a component (attenuator, directional coupler) connected ahead of the sensor by means of its S-parameter data set.
  Using S-parameters instead of a fixed offset allows more precise measurements, because the interaction between the sensor and the component can be taken into account.

[SENSe<Sensor>:]CORRection:DCYCle <duty_cycle>

Effective only in the Continuous average mode.

Sets the duty cycle as a percentage when pulse-modulated signals are corrected. With the correction activated, the sensor calculates pulse power from the duty cycle and the average power.

Parameters:

<duty_cycle>	Range:	0.001 to 100.00
	*RST:	1.00

Manual operation: See "Duty Cycle" on page 43

[SENSe<Sensor>:]CORRection:DCYCle:STATe <state>

Switches the duty cycle correction for the measured value on and off.

Parameters:

<state>	*RST:	OFF

Manual operation: See "Duty Cycle" on page 43

[SENSe<Sensor>:]CORRection:OFFSet <offset>

Sets a fixed offset in dB which is used to correct the measured value.

Parameters:

<offset> Range: -200.00 to 200.00
*RST: 0

Manual operation: See "Offset" on page 42

[SENSe<Sensor>:]CORRection:OFFSet:STATe <state>

Switches the offset correction on and off.

Parameters:

<state> *RST: OFF

Manual operation: See "Offset State" on page 42

[SENSe<Sensor>:]CORRection:SPDevice:LIST?

Queries the list of the S-parameter data sets that have been loaded to the power sensor. The result of the query indicates the consecutive number and mnemonic of each data set.

Usage: Query only

[SENSe<Sensor>:]CORRection:SPDevice:SELect <num>

Selects a loaded data set for S-parameter correction.

Parameters:

<num> Range: 1 to 1999
*RST: 1

[SENSe<Sensor>:]CORRection:SPDevice:STATe <state>

Switches the S-parameter correction on and off and activates the S-parameter data set, selected with `[SENSe<Sensor>:]CORRection:SPDevice:SELect`.

Parameters:

<state> *RST: OFF

Example:

```
CORR:SPD:SEL 1
```

Selects a S-parameter correction data set.

```
CORR:SPD:STAT ON
```

Activates the S-parameter correction.

6.5.5 Configuring the S-Gamma Parameters

Using the complex reflection coefficient you can determine the power P delivered by the signal source with considerably greater accuracy.

See also Chapter 5.1, "S-Parameters", on page 55.

[SENSe<Sensor>:]SGAMma:CORRection:STATe <state>

Activates/deactivates the use of the complex reflection coefficient 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 coeffiecient of the signal source Γ_{source} is defined with the commands `[SENSe<Sensor>:]SGAMma:MAGNitude` and `[SENSe<Sensor>:]SGAMma:PHASe`.

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.

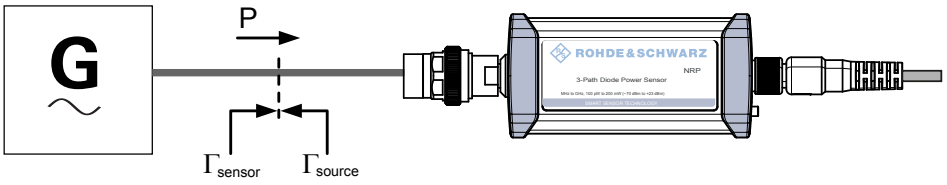


Figure 6-7: Correction of interactions between the power sensor and the signal source

If the gamma correction is made in connection with an s-parameter correction (setting `[SENSe<Sensor>:]CORRection:SPDevice:STATeON`), 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.

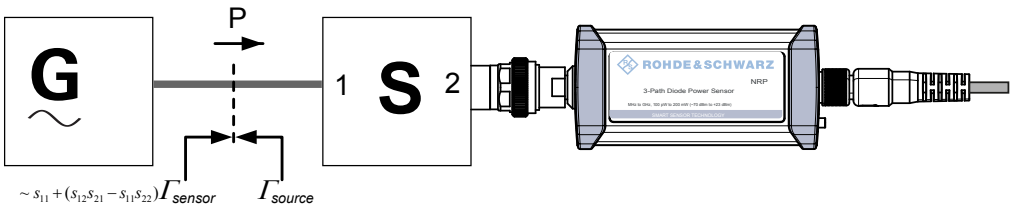


Figure 6-8: Correction of interactions between the power sensor, the signal source, and the sparameter device

Parameters:
<state> *RST: OFF

Example: `SENS:SGAM:PHAS 180`
Sets the phase for the Γ_{source} coefficient.
`SENS:SGAM:MAGN 0.1`
Sets the magnitude for the Γ_{source} coefficient.
`SGAM:CORR:STAT ON`
Activates the use of the Γ_{source} coefficient.

Manual operation: See "Γ Correction" on page 49

[SENSe<Sensor>:]SGAMma:MAGNitude <magnitude>

Sets the magnitude of the complex reflection coefficient of the source (Γ_{source}). A value of 0.0 corresponds to an ideal matched source and a value of 1.0 to total reflection.

Parameters:
<magnitude> Range: 0.0 to 1.0
*RST: 0.0

Manual operation: See "Magnitude" on page 49

[SENSe<Sensor>:]SGAMma:PHASe <phase>

Sets the phase angle of the complex reflection coefficient of the source (Γ_{source}).

Parameters:
<phase> Range: -360.0 to 360.0
*RST: 0.0

Manual operation: See "Phase" on page 49

6.6 Configuring the Trigger

In a basic continuous measurement, the measurement is started immediately after the start command. However, sometimes you want the measurement to start only when a

specific condition is fulfilled, for example a signal level is exceeded, or in certain time intervals. For these cases you can define a trigger for the measurement.

Trigger state system

The power sensors manages a trigger state system to SCPI 1999.0 to define the exact start and stop time of a measurement and the sequence of a measurement cycle. Four different device states are defined:

- **IDLE**: the power sensor performs no measurement. After a sensor is powered on it is automatically set to IDLE state.
- **INITIATED**: this is an internal temporary state which is passed while the trigger state system changes from MEASURING back to WAIT_FOR_TRG in continuous measurements (I. e. in `INIT:CONT ON` state). It has no visible implication.
- **WAIT_FOR_TRG**: the power sensor waits for a trigger event. The source for this event is set via `TRIGger:SOURce`. When the event defined in this way occurs, the sensor enters the MEASURING state.
- **MEASURING**: the power sensor is measuring data. It remains in this state and exits it immediately after completion of the measurement.

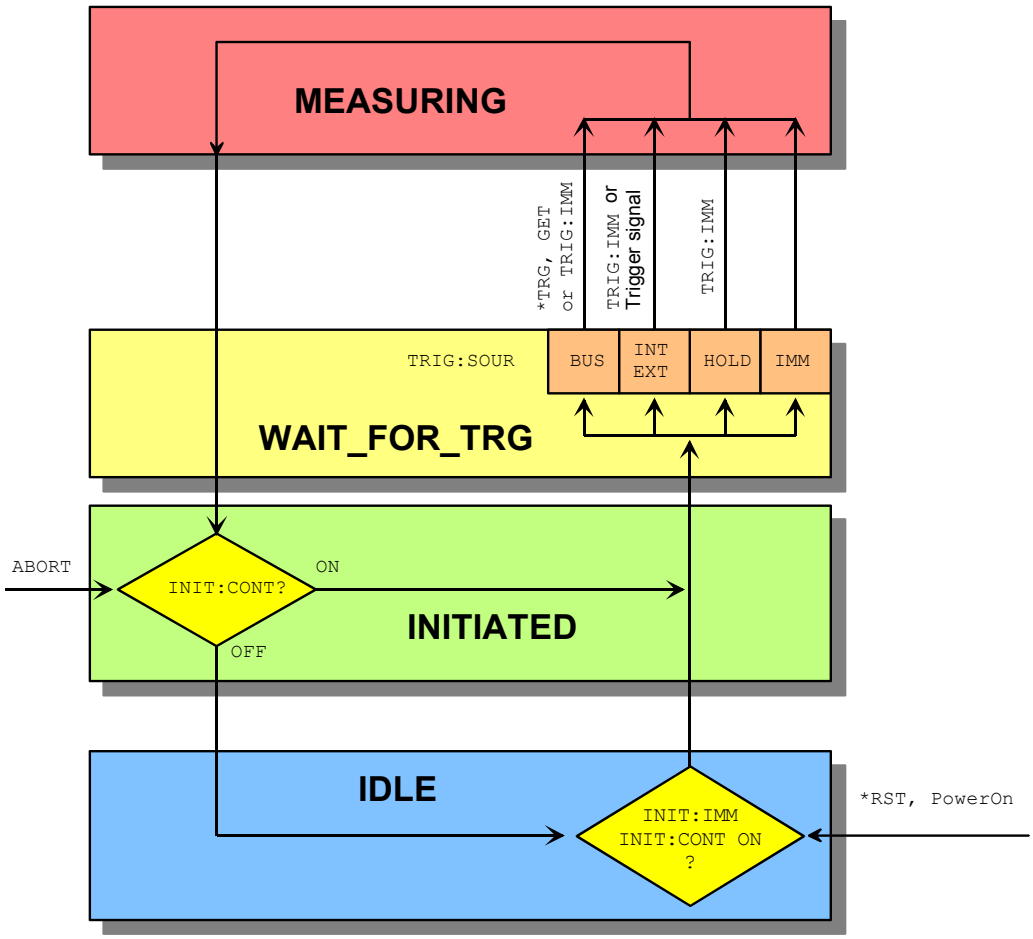


Figure 6-9: Overview of basic relationships in the trigger state system

Trigger measurement mode

Before a trigger can be executed the power sensor state has to be set to a state WAIT_FOR_TRG with the relevant `INITiate` command. Depending on the required number of measurement cycles the following modes are available:

- `CONTinuous`: in this mode, a new measurement cycle is automatically started after the previous one has been terminated.
- `IMMediate`: starts a single measurement cycle. Each sending of the `INIT:IMM` command initiates one result.

Trigger condition settings

The possible trigger conditions and the execution of a trigger depend on the selected trigger source.

When the signal power exceeds (`TRIG:SLOP POS`) or falls below (`TRIG:SLOP NEG` a reference level set by `TRIG:LEV`, the measurement is started after the time which has been set with `TRIG:DEL`.

In `TRIG:SOUR EXT`, waiting for a trigger event can be skipped by issuing a `TRIG:IMM` command.

ABORt

Immediately interrupts the current measurement. If the measurement has been started as a single measurement (`INITiate[:IMMediate]`) the sensor goes to IDLE state. However, if a continuous measurement is in progress (`INITiate:CONTinuousON`), the trigger system of the sensor advances to WAIT_FOR_TRG and if the trigger condition is met a new measurement is immediately started.

Usage: Event

INITiate:CONTinuous <state>

Activates/deactivates the continuous measurement mode. In continuous measurement mode the sensor does not reach the IDLE state after a measurement has been completed, but immediately executes another measurement cycle. This is commonly called the free-running mode although each measurement cycle is still depending on the trigger conditions.

Parameters:

<state>

ON
Measurements are performed continuously. If a measurement is completed, the sensor does not return to IDLE state but goes to WAIT_FOR_TRG state again.

OFF
Ends the continuous measurement mode and sets the sensor to IDLE.

*RST: OFF

Manual operation: See "Measurement" on page 42

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 command should only be used after the continuous measurement mode has been switched off with the (`INITiate:CONTinuousOFF`).

Usage: Event

TRIGger:ATRigger:EXECuted?

Returns the number of measurements which have be triggered automatically when `TRIGger:ATRigger:STATe` is set to `ON`.

In normal scalar measurements this number can only be 0 or 1. However, if a buffered measurement was executed this number indicates how many results in the returned array of measurement data were executed without a real trigger event.

Usage: Query only

TRIGger:ATRigger:STATe <state>

If the state is ON an artificial trigger is generated if more than 300 ms have elapsed after the start of measurement and no trigger event has occurred. The command is only evaluated in the Trace mode and, irrespective of the set averaging factor, only one trace will be recorded. The OFF state deactivates the automatic trigger function.

Parameters:

<state> *RST: OFF

TRIGger:COUNt <count>

Sets the number of measurement cycles to be performed when the measurement is started with INITiate[:IMMediate]. This number equals the number of results which can be obtained from the sensor after a single INITiate[:IMMediate]. As long as the defined number of measurements are not yet executed the sensors automatically initiates another measurement internally as soon as the current result is available.

TRIGger:COUNt is usable in particular in conjunction with buffered measurements, for example, to fill a buffer with a predefined size with measurements which have been triggered externally or by means of *TRG without the overhead of sending multiple measurement starts (INITiate[:IMMediate]).

Parameters:

<count> Range: 1 to 8192
*RST: 1

TRIGger:DELay <delay>

Sets the delay between the trigger event and the beginning of the actual measurement (integration).

Parameters:

<delay> Range: -5.0 to 10.0
*RST: 0.0
Default unit: s

Manual operation: See "Trigger Delay" on page 48

TRIGger:DELay:AUTO <state>

If TRIG:DEL:AUTO ON is selected, a measurement is not started until the sensor has settled. For this purpose the delay value is automatically determined.

The automatically determined delay is ignored if a longer period is set with

TRIGger:DELay .

Parameters:

<state> *RST: OFF

TRIGger:DTIMe <dropout_time>

Sets the drop-out time in seconds.

With a positive (negative) trigger slope, the dropout time is the minimum time for which the signal must be below (above) the power level defined by `TRIGger:LEVel` and `TRIGger:HYSTeresis` before triggering can occur again. As with the Holdoff parameter, unwanted trigger events can be excluded. The set dropout time only affects the INTernal trigger source.

The dropout time parameter is useful when dealing with, for example, GSM signals with several active slots Figure 6-10. When performing a measurement in sync with the signal, a trigger event is to be produced at A, but not at B or C. As the RF power between the slots is below the threshold defined by `TRIGger:LEVel` and `TRIGger:HYSTeresis`, the trigger hysteresis alone cannot prevent triggering at B or at C. This is why the dropout time parameter is selected to be greater than the time elapsed between points D and B and between E and C, but less than the time elapsed between F and A. This ensures that triggering will take place at A.

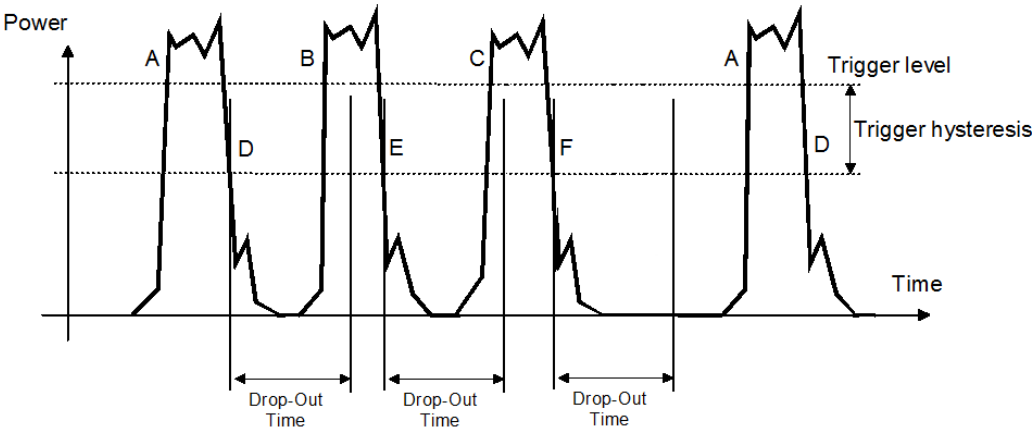


Figure 6-10: Significance of the drop-out time parameter

As the mechanism associated with the dropout time parameter is reactivated whenever the trigger threshold is crossed, unambiguous triggering can also be obtained for many complex signals. By contrast, all triggering is suppressed during the hold-off time. For the example described, this would mean that although stable triggering conditions could be obtained with a suitable hold-off time (regular triggering at the same point), it would not be possible to set exclusive triggering at A.

Note:

In Burst mode a similar response is achived with the `[SENSe<Sensor>:][POWer:]BURSt:DTOLerance` command (drop-out tolerance). However, while `TRIGger:DTIMe` makes sure that the sensor is always triggering at the right slope, in Burst mode the drop-out tolerance setting ensures that the burst measurement is not discountinued too early.

Parameters:

<dropout_time> Range: 0.00 to 10.00
*RST: 0.00
Default unit: s

Manual operation: See "Dropout" on page 53

TRIGger:EXTernal<2...2>:IMPedance <impedance>

Sets termination resistance of the second external trigger input (`EXTernal2`). You can select between `HIGH` (~ 10 kOhm) and `LOW` (50 Ohm) to fit the impedance of the trigger source and thus minimize reflections on the trigger signals.

Suffix:

<2...2> 2...2

Parameters:

<impedance> HIGH | LOW
*RST: HIGH

TRIGger:HOLDoff <holdoff>

Sets the hold off time in seconds, a period after a trigger event within which all further trigger events are ignored, see Figure 6-11.

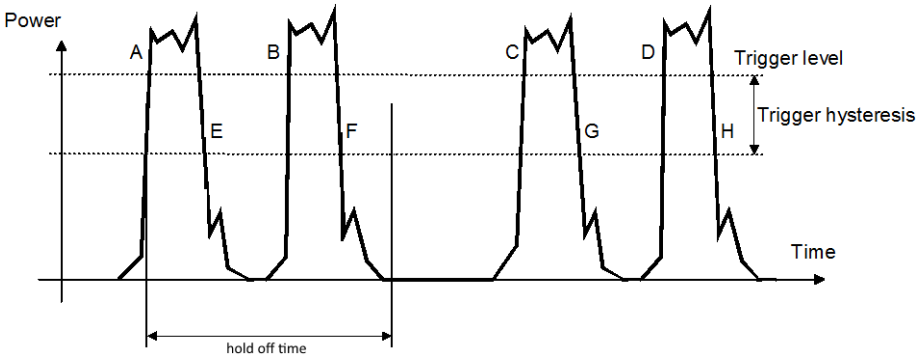


Figure 6-11: Effect of the trigger hold off time

Parameters:

<holdoff> Range: 0.00 to 10.00
*RST: 0.00

Manual operation: See "Holdoff" on page 53

TRIGger:HYSTeresis <hysteresis>

Sets the hysteresis, the magnitude (in dB) the trigger level of the signal must fall below the trigger threshold on a rising slope or rise above the trigger threshold on a falling slope before another trigger event occurs. Thus, this command can be used to eliminate the effects of noise in the signal on the edge detector of the trigger system.

Parameters:

<hysteresis> Range: 0.00 to 10.00
*RST: 0.00
Default unit: DB

Manual operation: See "Hysteresis" on page 53

TRIGger:IMMediate

Triggers a generic trigger event that causes the sensor to immediately exit the WAIT_FOR_TRIGGER state irrespective of the trigger source and the trigger delay and start the measurement. The command is the only means of starting a measurement when the trigger source is set to HOLD. Only one measurement cycle is executed irrespective of the averaging factor.

Usage: Event

TRIGger:LEVel <level>

Effective only when `TRIGger:SOURceINTernal`.

Sets the trigger threshold for internal triggering derived from the test signal (in W).

This setting is irrelevant for all other trigger sources than `INTernal`. If an S-parameter device is active and/or if a mounted component with a global offset in front of 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 data. When the S-parameter device and/or the offset correction are switched off, then the trigger threshold and its input limits are adjusted as necessary.

Parameters:

<level> Range: 10.0e-7 to 200.0e-3
*RST: 1.0e-3
Default unit: Watts

Manual operation: See "Trigger Level" on page 44

TRIGger:MASTer:STATe <state>

Activates/deactivates the trigger master mode of the sensor. In this state the sensor can output a digital trigger signal in sync with its own trigger event.

When the trigger master state is `ON` the user must select on which external port the sensor should output its trigger event. See `TRIGger:MASTer:PORT` command for selecting this.

A sensor which is trigger master is typically set to internal triggering, but this is not a requirement. The trigger master sensor may very well be triggered externally also, because the sensor has got two external trigger connections. However, if external triggering is desired for the trigger master sensor, the external trigger input must be the "other" one as the trigger master output port (`EXTernal1` vs. `EXTernal2`)

Parameters:
<state> *RST: OFF

TRIGger:MASTer:PORT <master_port>

Selects the external connection where the sensor outputs its own trigger event in case it is trigger master. See `TRIGger:MASTer:STATe` for more information.

The sensor can output its trigger event either on the `EXTernal<1>` or `EXTernal2` port when it is the trigger master. If the trigger master is to be triggered externally by itself, its trigger source must be configured to the other external port respectively, i.e:

```
TRIGger:MASTer:PORT    EXT1
TRIGger:SOURce         EXT2
TRIGger:MASTer:STATe ON
```

or

```
TRIGger:MASTer:PORT    EXT2
TRIGger:SOURce         EXT1
TRIGger:MASTer:STATe ON
```

Parameters:
<master_port> EXT1 | EXTernal1 | EXT2 | EXTernal2
*RST: EXT1

TRIGger:SLOPe <slope>

Available only if `TRIGger:SOURce` is set to `INTernal` or `EXTernal`.

Determines whether the rising (`POSitive`) or the falling (`NEGative`) edge of the envelope power (with internal triggering) or increasing voltage (with external triggering) is used for triggering.

Parameters:
<slope> POSitive | NEGative
*RST: POSitive

Manual operation: See "Trigger Slope" on page 46

TRIGger:SOURce <source>

Selects the source for the Trigger event detector.

Parameters:

<source> HOLD | IMMediate | INTernal | BUS | EXTernal | EXT1 | EXTernal1 | EXT2 | EXTernal2

BUS
Triggering is started with the commands `*TRG` or `TRIGger:IMMediate`, where `TRIGger:IMMediate` shortens the measurement. In this case, the other trigger setting are meaningless.

EXTernal
Triggering is initiated via the hardware trigger bus, e.g via the base unit. Waiting for a trigger event can be skipped by `TRIGger:IMMediate`.
`EXT`, `EXT1`, `EXTernal` and `EXTernal1` denote the same, an external trigger applied through the round 8 pin connector.
`EXT2` and `EXTernal2` refer to external triggering initiated by the dedicated SMB type connector, TRIG2 I/O, in the rear of the sensor.

HOLD
A triggering is started with the command `TRIGger:IMMediate`.

IMMediate
No waiting for an event occurs.

INTernal
Triggering is started by the measurement signal.
When this signal exceeds (`TRIGger:SLOPe POS`) or drops below (`TRIGger:SLOPe NEG`) the power set by `TRIGger:LEVel`, the measurement is started after the time set by `TRIGger:DELay`. Similar to `TRIGger:SOURce EXT`, waiting for a trigger event can also be skipped by `TRIGger:IMMediate`.

*RST: IMMediate

Manual operation: See "Trigger Source" on page 46

TRIGger:SYNC:STATe <state>

If set to `ON`, the command blocks the external trigger bus as long as the sensor remains in the measurement state. It is usually used in combination with the command `TRIGger:MASTer:STATe` and makes certain, that a new measurement will only be started after all sensors have completed their last measurement.

It must be ensured that the number of repetitions is the same for all the sensors involved in the measurement. Otherwise, the trigger bus will be blocked by any sensor that has completed its measurements before the others and has returned to the IDLE state.

Parameters:

<state> *RST: OFF

TRIGger:SYNC:PORT <sync_port>

Selects the external connection for the sensor's sync output. See `TRIGger:SYNC:STATe` for more information.

Parameters:
<sync_port> EXT1 | EXTernal1 | EXT2 | EXTernal2

6.7 Using the Status Register

For more information on the contents of the status registers see:

- Chapter A.2.3, "Status Byte (STB) and Service Request Enable Register (SRE)", on page 144
- Chapter A.2.5, "Device Status Register", on page 146
- Chapter A.2.6.1, "Questionable Power Status Register", on page 147
- Chapter A.2.6.2, "Questionable Calibration Status Register", on page 148
- Chapter A.2.7, "Standard Event Status and Enable Register (ESR, ESE)", on page 148
- Chapter A.2.8.1, "Operation Calibrating Status Register", on page 151
- Chapter A.2.8.2, "Operation Measuring Status Register", on page 152
- Chapter A.2.8.3, "Operation Trigger Status Register", on page 152
- Chapter A.2.8.4, "Operation Sense Status Register", on page 153
- Chapter A.2.8.5, "Operation Lower Limit Fail Status Register", on page 153
- Chapter A.2.8.6, "Operation Upper Limit Fail Status Register", on page 154

6.7.1 General Status Register Commands

STATus:PRESet

Resets the edge detectors and `ENABle` parts of all registers to a defined value.

Usage: Event

STATus:QUEue[:NEXT]?

Queries the most recent error queue entry and deletes it.

Positive error numbers indicate sensor specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

Usage: Query only

6.7.2 Reading Out the CONDition Part

For more information on the CONDition part see Chapter A.2.2, "Structure of a SCPI Status Register", on page 143.

STATus:DEVice:CONDition?
STATus:OPERation:BIT<<8...12>:CONDition?
STATus:OPERation:CALibrating:CONDition?
STATus:OPERation:CONDition?
STATus:OPERation:LLFail:CONDition?
STATus:OPERation:MEASuring:CONDition?
STATus:OPERation:SENSe:CONDition?
STATus:OPERation:TRIGger:CONDition?
STATus:OPERation:ULFail:CONDition?
STATus:QUEStionable:BIT<<9...12>:CONDition?
STATus:QUEStionable:CALibration:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:POWer:CONDition?

These commands read out the `CONDition` section of the status register.

The commands do not delete the contents of the `CONDition` section.

Usage: Query only

6.7.3 Reading Out the EVENt Part

For more information on the EVENt part see Chapter A.2.2, "Structure of a SCPI Status Register", on page 143.

STATus:DEVice[:EVENt]?
STATus:OPERation:BIT<<8...12>[:EVENt]?
STATus:OPERation:CALibrating[:SUMMary][:EVENt]?
STATus:OPERation[:EVENt]?
STATus:OPERation:LLFail[:SUMMary][:EVENt]?
STATus:OPERation:MEASuring[:SUMMary][:EVENt]?
STATus:OPERation:SENSe[:SUMMary][:EVENt]?
STATus:OPERation:TRIGger[:SUMMary][:EVENt]?
STATus:OPERation:ULFail[:SUMMary][:EVENt]?
STATus:QUEStionable:BIT<<9...12>[:EVENt]?

STATus:QUEStionable:CALibration[:SUMMary][:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:POWer[:SUMMary][:EVENt]?

These commands read out the `EVENt` section of the status register.

At the same time, the commands delete the contents of the `EVENt` section.

Usage: Query only

6.7.4 Controlling the ENABle Part

For more information on the ENABLe part see Chapter A.2.2, "Structure of a SCPI Status Register", on page 143.

STATus:DEVice:ENABle <value>
STATus:OPERation:BIT<<8...12>:ENABle [<arg0>]
STATus:OPERation:CALibrating:ENABle <value>
STATus:OPERation:ENABle <value>
STATus:OPERation:LLFail:ENABle <value>
STATus:OPERation:MEASuring:ENABle <value>
STATus:OPERation:SENSe:ENABle <value>
STATus:OPERation:TRIGger:ENABle <value>
STATus:OPERation:ULFail:ENABle <value>
STATus:QUEStionable:BIT<<9...12>:PTRansition [<arg0>]
STATus:QUEStionable:CALibration:ENABle <value>
STATus:QUEStionable:ENABle <value>
STATus:QUEStionable:POWer:ENABle <value>

These commands control the `ENABle` part of a register.

The `ENABle` part allows true conditions in the `EVENt` part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:
<value> *RST: 0

6.7.5 Controlling the Negative Transition Part

For more information on the negative transition part see Chapter A.2.2, "Structure of a SCPI Status Register", on page 143.

STATus:DEVice:NTRansition <value>
STATus:OPERation:BIT<<8...12>:NTRansition [<arg0>]
STATus:OPERation:CALibrating:NTRansition <value>
STATus:OPERation:NTRansition <value>
STATus:OPERation:LLFail:NTRansition <value>
STATus:OPERation:MEASuring:NTRansition <value>
STATus:OPERation:SENSe:NTRansition <value>

STATus:OPERation:TRIGger:NTRansition <value>
STATus:OPERation:ULFail:NTRansition <value>
STATus:QUEStionable:BIT<<9...12>:NTRansition [<arg0>]
STATus:QUEStionable:CALibration:NTRansition <value>
STATus:QUEStionable:NTRansition <value>
STATus:QUEStionable:POWer:NTRansition <value>

These commands control the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Parameters:
<value> *RST: 0

6.7.6 Controlling the Positive Transition Part

For more information on the positive transition part see Chapter A.2.2, "Structure of a SCPI Status Register", on page 143.

STATus:DEVice:PTRansition <value>
STATus:OPERation:BIT<<8...12>:PTRansition [<arg0>]
STATus:OPERation:CALibrating:PTRansition <value>
STATus:OPERation:PTRansition <value>
STATus:OPERation:LLFail:PTRansition <value>
STATus:OPERation:MEASuring:PTRansition <value>
STATus:OPERation:SENSe:PTRansition <value>
STATus:OPERation:TRIGger:PTRansition <value>
STATus:OPERation:ULFail:PTRansition <value>
STATus:QUEStionable:CALibration:PTRansition <value>
STATus:QUEStionable:POWer:PTRansition <value>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Parameters:
<value> *RST: 65535

6.8 Testing the Power Sensor

The selftest allows a test of the internal circuitry of the sensor.

TEST:SENSor? [<Item>]

Triggers a selftest of the sensor. In contrast to `*TST?`, this command yields detailed information, which is useful for troubleshooting.

Note: 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*.

Query parameters:
<Item>

Usage: Query only

Manual operation: See "Diagnostics" on page 49

6.9 Calibrating/Zeroing the Power Sensor

Zeroing removes offset voltages from the analog circuitry of the sensors, so that there are only low powers displayed when there is no power applied. The zeroing process may take more than 8 seconds to complete .

Zeroing is recommended if:

- The temperature has varied by more than 5°C.
- The sensor has been replaced.
- No zeroing was performed in the last 24 hours.
- Signals of very low power are to be measured, for instance, if the expected measured value is less than 10 dB above the lower measurement range limit.

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

CALibration:DATA <caldata>

Writes a binary calibration data sets in the memory of the sensor.

Parameters:
<caldata> <block_data>

CALibration:DATA:LENGth?

Queries the length in bytes of the calibration data set currently stored in the flash memory. Programs that read out the calibration data set can use this information to determine the capacity of the buffer memory required.

Usage: Query only

CALibration:ZERO:AUTO <state>

Performs zeroing using the signal at the sensor input. The sensor must be disconnected from all power sources.

The setting command accepts only the parameter `ONCE`; `OFF` and `ON` are ignored.

The query returns the value `ON` if a calibration is in progress, otherwise the value `OFF`.

Parameters:
<state> *RST: OFF

Manual operation: See "Zero Calibration" on page 49

7 Performing Measurement Tasks - Programming Examples

Programming example for performing measurement tasks with the power sensors are given in the following chapter.

7.1 Performing the Simplest Measurment

The simplest way to obtain a result is to use the following sequence of commands:

```
*RST
INIT
FETCh?
```

The `*RST` will set the Continuous Average mode.

`INIT` initiates the measurement.

After `*RST`, the trigger system is set to `TRIG:SOUR IMM` so that the trigger system state changes to `MEASURING` via `INITIATED` and `WAIT_FOR_TRG`.

After the measurement has been completed, `FETCh?` delivers the result to the output queue from which it can be fetched.

7.2 Performing the Fastest Measurement in Continuous Average Mode

The fastest way to obtain results for different continuous measurements is described in this chapter.

Fastest Measurement for Continuous Measurements

1. Reset the sensor.
   `*RST`
2. Sets the apperture time to 10 us.
   `SENSE:POW:AVG:APER 10e-6`
3. Set the averaging filter length to 1.
   `SENSE:AVER:COUNT 1`
4. Disable auto averaging.
   `SENSE:AVER:COUNT:AUTO OFF`
5. Enable the fast unchopped continuous average measurement.
   `SENS:POW:AVG:FAST ON`
6. Set the buffer size.

```
SENS:BUFF:SIZE 8192
```

7. Enables the buffer for continuous average results.
   ```
   SENS:BUFF:STAT ON
   ```
8. Set the data format to real.
   ```
   FORMAT:DATA REAL
   ```
9. Initiate a continuous measurement.
   ```
   INIT:CONT ON
   ```
10. Set a suitable sleep time.
    In order to achieve the maximum measurement speed, the buffer level should never reach the buffer size. But, the results should also not be fetched too fast. Therefore a sleep time between two consecutive `SENS:POW:AVG:BUFF:DATA?` queries is meaningful. Since the sensor reaches approximately 50000 measurements per second in this setup, 50...80 ms is a suitable sleep time. Then you'll get 2500...4000 measurements per `SENS:POW:AVG:BUFF:DATA?` query (--sleep 60 ms--).
11. Fetch available results.
    ```
    SENS:POW:AVG:BUFF:DATA?
    ```
12. Repeat steps 10. and 11. as often as is needed
13. Stop the continuous measurement.
    ```
    INIT:CONT OFF
    ```

Fastest Measurement for Counting Pulses

1. Reset the sensor.
   ```
   *RST
   ```
2. Select the internal trigger source.
   ```
   TRIG:SOUR INT
   ```
3. Set the trigger level.
   ```
   TRIG:LEV 0.0001
   ```
4. Disable auto averaging.
   ```
   SENS:AVER:COUN:AUTO OFF
   ```
5. Enable the fast unchopped continuous average measurement.
   ```
   SENS:POW:AVG:FAST ON
   ```
6. Set the apperture time to 10 us.
   ```
   SENS:POWER:AVG:APER 10e-6
   ```
7. Disable the averaging filter.
   ```
   SENSE:AVER:STATE OFF
   ```
8. Set the buffer size.
   ```
   SENS:BUFF:SIZE 8192
   ```
9. Enables the buffer for continuous average results.

```
SENS:BUFF:STAT ON
```

10. Initiate a continuous measurement.
    ```
    INIT:CONT ON
    ```
11. Fetch the number of results that is currently stored in the buffer after the measurement is done.
    ```
    SENS:POW:AVG:BUFF:COUN?
    ```

7.3 Performing Trace Measurements

To perform a trace measurement:

1. Reset the sensor.
   ```
   *RST
   ```
2. Set the sensor's operation mode to trace.
   ```
   SENSe:FUNCtion "XTIMe:POWer"
   ```
3. Set the carrier frequency.
   ```
   SENSe:FREQuency 1.8e9
   ```
4. Set the number of points for the trace measurement. Using 500 points usually represents a good compromise between USB transfer speed and resolution.
   ```
   SENSe:TRACe:POINTs 500
   ```
5. Set the trace time. It influences the time length of a point, since each point represents the time period resulting from the trace time divided by the number of points.
   ```
   SENSe:TRACe:TIMe 20e-3
   ```
6. If required set the trace offset time. This will delay the start point of the trace measurement for the specified time.
   ```
   SENSe:TRACe:OFFSet:TIME 50e-6
   ```
7. Configure the trigger condition:
   - Set the trigger source.
     ```
     TRIGger:SOURce INTernal
     ```
   - Set the trigger slope.
     ```
     TRIGger:SLOPe POSitive
     ```
   - If required set a dropout time.
     ```
     TRIGger:DTIMe 0.001
     ```
   - Set the hysteresis.
     ```
     TRIGger:HYSTeresis 0.1
     ```
   - Set the trigger level.
     ```
     TRIGger:LEVel 30e-6
     ```
8. Enable and configure the averaging filter.
   ```
   SENSe:TRACe:AVERage:COUNt 8
   SENSe:TRACe:AVERage:STATe ON
   ```

9. Optionally select the data output format.
   `FORMat:DATA REAL`
   `FORMat:DATA ASC`
10. Initiate the measurement.
    `INIT`
11. Query the measurement results.
    `FETCh?`

7.4 Trace Measurement with Synchronization to Measurement Complete

This example, written in pseudo code, shows how to setup and execute a trace measurement using a non-blocking technique.

The advantage of using the `FETCH?` command (as shown in the previous example) is, that `FETCH?` will wait (block) until a measurement result is available. However this may lead to situations where an application blocks for a longer time (until timeout) if, for example, a trigger is missing and thus no results will ever become available.

For certain applications, especially interactive ones, it is not the desired behavior that the user has to wait until a (probably long) timeout occurs. In these cases it is preferred to start a measurement and then enter a loop to poll the sensor until the measurement is ready and the results can safely be retrieved. For such applications it is recommended to use the status system of the sensor to find out whether the measurement is ready. The advantage of this approach is that the polling loop can be exited/canceled at any time and the application stays operable (i. e. does not block).

```
// basic setup, similar to the previous example
write( "*RST" );
write( "SENS:FUNC \"XTIM:POW\"" );
write( "SENS:FREQ  1.8e9" );
write( "SENS:TRAC:POIN 500" );
write( "SENS:TRAC:TIME  20e-3" );
write( "TRIG:SOUR INT" );
write( "TRIG:SLOP POS" );
write( "TRIG:DTIM 0.001" );
write( "TRIG:HYST  0.1" );
write( "TRIG:LEV  30e-6" );
write( "SENS:TRAC:AVER:COUN  8" );
write( "SENS:TRAC:AVER:STAT  ON" );

// configuring the event system to recognize the
// end of measurement (i.e. a negative transition
// of bit 1 in the meas operation register)
write( "STAT:OPER:MEAS:NTR  2" );
write( "STAT:OPER:MEAS:PTR  0" );
```

```
// resetting the event information by an initial readout
int iEvent = 0;
query( "STAT:OPER:MEAS:EVEN?", &iEvent );

// Now starting the measurement
write( "INIT:IMM" );

bool bMeasReady = false;

// poll until measurement is ready...
// (this loop could also check for cancel-requests
//  from the user or other break conditions)
    while ( ! bMeasReady )
{
       query( "STAT:OPER:MEAS:EVEN?", &iEvent );
       bMeasReady = ((iEvent & 0x02) != 0);

       if ( ! bMeasReady )
           sleep( 1 );
}

if ( bMeasReady )
{
       query( "SENS:TRAC:DATA?", bufResult );

       // further process the result in 'bufResult'...
       // ::
       // ::
}
```

Annex

A Remote Control Basics

A.1 SCPI Command Structure

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. The power sensor supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers.

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (keywords). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.

A.1.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (*) and possibly one or more parameters.

Examples:

*RST	RESET	Resets the instrument.
*ESE	EVENT STATUS ENABLE	Sets the bits of the event status enable registers.
*ESR?	EVENT STATUS QUERY	Queries the contents of the event status register.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.

A.1.2 Syntax for Device-Specific Commands

Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

Example:

`INITiate:CONTinuous` is equivalent to `INIT:CONT`.

Case-insensitivity

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

Numeric suffixes

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

Different numbering in remote control

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

Optional mnemonics

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

Example:

Definition: `INITiate[:IMMediate]`

Command: `INIT:IMM` is equivalent to `INIT`

Parameters

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

For a description of the parameter types, refer to Chapter A.1.3, "SCPI Parameters", on page 137.

Special characters

|	**Parameters** A vertical stroke in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.
[ ]	Mnemonics in square brackets are optional and may be inserted into the header or omitted. **Example**: `INITiate[:IMMediate]` `INIT:IMM` is equivalent to `INIT`
{ }	Parameters in curly brackets are optional and can be inserted once or several times, or omitted.

A.1.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). Allowed parameters are:

- Numeric values
- Special numeric values
- Boolean parameters
- Text
- Character strings
- Block data

The parameters required for each command and the allowed range of values are specified in the command description.

Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Allowed unit prefixes are G (giga), MA (mega), MOHM and MHZ are also allowed), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

Units

For physical quantities, the unit can be entered. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

If the unit is missing, the basic unit is used.

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the PCT string.

Special numeric values

The texts listed below are interpreted as special numeric values. In the case of a query, the numeric value is provided.

- **MIN/MAX**
  MINimum and MAXimum denote the minimum and maximum value.
- **DEF**
  DEFault denotes a preset value which has been stored in the non variable memory. This value conforms to the default setting, as it is called by the *RST command.
- **UP/DOWN**
  UP, DOWN increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.
- **INF/NINF**
  INFinity, Negative INFinity (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.
- **NAN**
  Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument response. This value is not defined. Possible causes are the division with zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0. The numeric values are provided as the response for a query.

Example:

Setting command: SENSe:AVERage:COUNt:AUTO ON

Query: SENSe:AVERage:COUNt:AUTO?

Response: 1

Text parameters

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example:

Setting command: `TRIGger:SLOPe POSitive`

Query: `TRIG:SLOP?`

Response: `POS`

Character strings

Strings must always be entered in quotation marks (' or ").

Example:

Setting command: `SENSe:FUNCtion "POWer:AVG"`

Query: `SENS:FUNC?`

Response: `"POWer:AVG"`

Block data

Block data is a format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example:

`SYSTem:HELP:SYNTax:ALL?`

`Response: #45168xxxxxxxx`

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted.

#0 specifies a data block of indefinite length. The use of the indefinite format requires a `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

A.1.4 Overview of Syntax Elements

The following table provides an overview of the syntax elements:

:	The colon separates the mnemonics of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*****	The asterisk marks a common command.

' "	Quotation marks introduce a string and terminate it (both single and double quotation marks are possible).
#	The hash symbol introduces binary, octal, hexadecimal and block data. • Binary: #B10110 • Octal: #O7612 • Hexa: #HF3A7 • Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

A.1.5 Structure of a command line

A command line may consist of one or several commands. It is terminated by one of the following:

- a <New Line>
- a <New Line> with EOI
- an EOI together with the last data byte

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

Example:

```
TRIG:LEV 0.1mW;TRIG:DEL 3E-3
```

This command line contains two commands. Both commands are part of the `TRIG` command system, i.e. they have one level in common.

When abbreviating the command line, the second command begins with the level below `TRIG`. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

```
TRIG:LEV 0.1E-3;DEL 3E-3
```

A new command line always begins with the complete path.

Example:

```
TRIG:LEV 0.1E-3
TRIG:DEL 3E-3
```

A.1.6 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to

SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

- The requested parameter is transmitted without a header.
  Example: `TRIG:SOUR?`, Response: `INT`
- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.
- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the `Unit` command. The response `3.5E9` for example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as `0` (for `OFF`) and `1` (for `ON`).
  Example:
  Setting command: `SENS:AVER:COUN:AUTO ON`
  Query: `SENS:AVER:COUN:AUTO?`
  Response: `1`
- Text (character data) is returned in a short form.
  Example:
  Setting command: `TRIGger:SOURce INTernal`
  Query: `TRIG:SOUR?`
  Response: `INT`

A.2 Status Reporting System

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

A.2.1 Hierarchy of the Status Registers

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

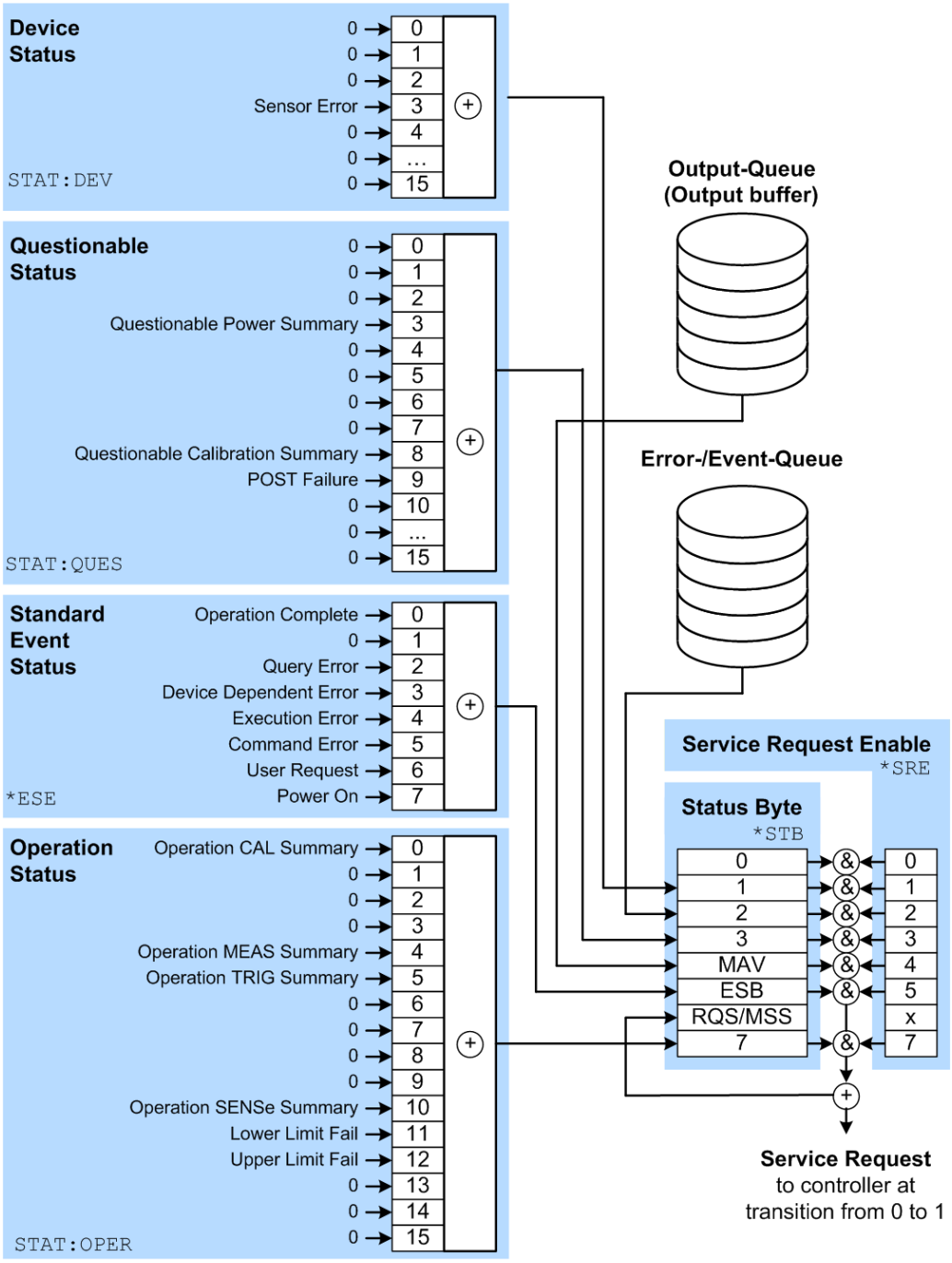


Figure A-1: Graphical overview of the status registers hierarchy

The highest level is formed by the Status Byte Register (`STB`) and the associated Service Request Enable (`SRE`) register.

The `STB` receives its information from the Standard Event Status Register (`ESR`) and the associated Standard Event Status Enable (`ESE`) Register, as well as from the SCPI-defined Operation Status Register, and the Questionable Status Register, which contain detailed information on the device, and from the Device Status Register.

A.2.2 Structure of a SCPI Status Register

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

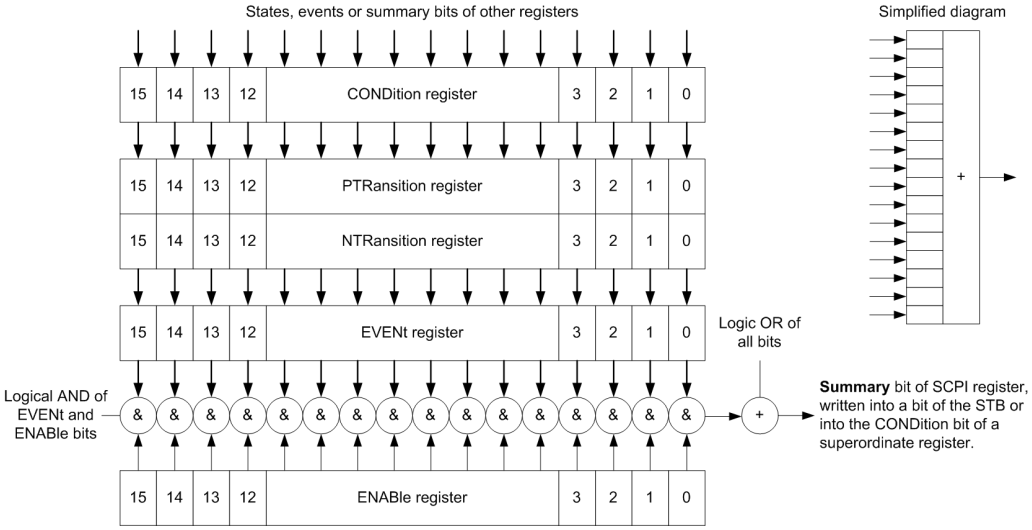


Figure A-2: Standard SCPI status register

Description of the five status register parts

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

- **CONDition**
  The `CONDition` part is written into directly by the hardware or the sum bit of the next lower register. Its contents reflect the current instrument status. This register part can only be read, but not written into or cleared. Its contents are not affected by reading.
- **PTRansition / NTRansition**
  The two transition register parts define which state transition of the `CONDition` part (none, 0 to 1, 1 to 0 or both) is stored in the `EVENt` part.
  The **Positive-TRansition** part acts as a transition filter. When a bit of the `CONDition` part is changed from 0 to 1, the associated `PTR` bit decides whether the `EVENt` bit is set to 1.
  – `PTR` bit =1: the `EVENt` bit is set.
  – `PTR` bit =0: the `EVENt` bit is not set.
  This part can be written into and read as required. Its contents are not affected by reading.
  The **Negative-TRansition** part also acts as a transition filter. When a bit of the `CONDition` part is changed from 1 to 0, the associated `NTR` bit decides whether the `EVENt` bit is set to 1.
  – `NTR` bit =1: the `EVENt` bit is set.

– NTR bit =0: the EVENt bit is not set.

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

- **EVENt**
  The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument.
  This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.
- **ENABle**
  The ENABle part determines whether the associated EVENt bit contributes to the sum bit (see below). Each bit of the EVENt part is "ANDed" with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an "OR" function (symbol '+').
  ENABle bit = 0: the associated EVENt bit does not contribute to the sum bit
  ENABle bit = 1: if the associated EVENt bit is "1", the sum bit is set to "1" as well.
  This part can be written into and read by the user as required. Its contents are not affected by reading.

Sum bit

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

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

A.2.3 Status Byte (STB) and Service Request Enable Register (SRE)

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

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

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

Table A-1: Meaning of bits used in the status byte

Bit No.	Meaning
0	Not used
1	**Device Status Register summary bit** Depending on the configuration of the sensors status register, this bit is set when a sensor is connected or disconnected or when an error has occurred in a sensor
2	**Error Queue not empty** The bit is set if the error queue has an entry. If this bit is enabled by the SRE, each entry of the error queue will generate a service request. An error can thus be recognized and specified in detail by querying the error queue. The query yields a conclusive error message. This procedure is recommended since it considerably reduces the problems of IEC/IEEE-bus control.
3	**Questionable Status Register summary bit** This bit is set if an EVENt bit is set in the QUEStionable Status Register and the associated ENABLe bit is set to 1. A set bit denotes a questionable device status which can be specified in greater detail by querying the QUEStionable Status Register.
4	**MAV-Bit** (Message available) This bit is set if a readable message is in the output queue. This bit may be used to automate reading of data from the sensor into the controller.
5	**ESB: Standard Event Status Register summary bit** This bit is set if one of the bits in the Standard Event Status Register is set and enabled in the Event Status Enable Register. Setting this bit denotes a serious error which can be specified in greater detail by querying the Standard Event Status Register.
6	**MSS: Master-Status summary bit** This bit is set if the sensor triggers a service request. This is the case if one of the other bits of this register is set together with its enable bit in the Service Request Enable register SRE.
7	**Operation Status Register summary bit** This bit is set if an EVENt bit is set in the Operation Status Register and the associated ENABLe bit is set to 1. A set bit denotes that an action is being performed by the sensor. Information on the type of action can be obtained by querying the Operation Status Register.

A.2.4 IST Flag and Parallel Poll Enable Register (PPE)

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

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

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

A.2.5 Device Status Register

This register contains information on the state of the static errors, that can be queried with the command `SYSTem:SERRor?`. Additionally, bit 7 gives information on the current operating state of the NRP legacy interface.

The register can be read by the queries:

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

Table A-2: Meaning of bits used in the Device Status Register

Bit No.	Meaning
0	**Sum of SERR bits** The sum/combination of SERR bits 1 to 4.
1	**SERR measurement not possible** Static error (SERR) exists; certain parameter settings could lead to a situation where subsequent measurements are not possible (for example, a Timeslot measurement with a configured timeslot width of 0.0)
2	**SERR erroneous results** Static error exists; the measurement result is possibly incorrect.
3	**SERR warning** A static error exists therefore the Status LED of the power sensor is blinking slowly in red.
4	**SERR critical** A critical static error exists therefore the Status LED of the power sensor is blinking fast in red.
5 to 6	Not used
7	**Legacy Locked state** The power sensors is locked in the NRP Legacy mode. Via the SCPI channels (USBTMC or TCP/IP) only the usage of query commands is possible, and no setting commands. The NRP legacy interface takes precedence over all other command channels as soon as the first setting command is sent via this interface. Then this bit is set to 1 and all other channels can subsequently only execute query commands. If a setting command is sent via a different channel anyhow, the sensor raises an error: *-200,"Execution error;sensor in LEGACY mode"* To leave this operating mode the NRP legacy channel needs to be closed, i. e. the application which opened the NRP legacy channel should be closed, or should at least close the connection to the sensor.
8 to 15	Not used

A.2.6 Questionable Status Register

This register contains information on questionable sensor states. Such states may occur when the sensor is not operated in compliance with its specifications.

The register can be read by the queries:

- `STATus:QUEStionable:CONDition?`

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

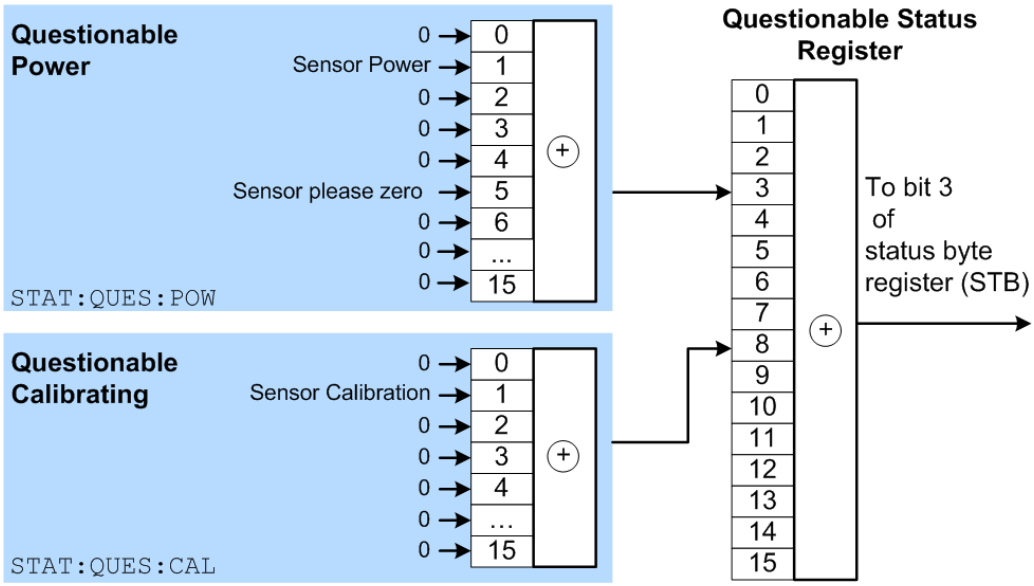


Table A-3: Meaning of bits used in the Questionable Status Register

Bit No.	Meaning
0 to 2	Not used
3	**Questionable Power Status Register summary bit** Corresponds to the summary bit of the Questionable Power Status Register.
4 to 7	Not used
8	**Questionable Calibration Status Register summary bit** Corresponds to the summary bit of the Questionable Calibration Status Register.
9	**POST Failure** The built-in test of the R&S NRPxxS[N] carried out automatically upon power-up has generated an error.
10 to 15	Not used

A.2.6.1 Questionable Power Status Register

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

The register can be read by the queries:

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

Table A-4: Meaning of bits used in the Questionable Power Status Register

Bit No.	Meaning
0	Not used
1	**Sensor Power** The measurement data of the sensor is corrupt.
2 to 4	Not used
5	**Sensor please zero** The zero correction for the sensor is no longer correct and should be repeated.
6 to 15	Not used

A.2.6.2 Questionable Calibration Status Register

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

The register can be read by the queries:

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

Table A-5: Meaning of bits used in the Questionable Calibration Status Register

Bit No.	Meaning
0	Not used
1	**Sensor Calibration** Zeroing of the sensor was not successful.
2 to 15	Not used

A.2.7 Standard Event Status and Enable Register (ESR, ESE)

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

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

Table A-6: Meaning of bits used in the Standard Event Status Register

Bit No.	Meaning
0	**Operation Complete** When the `*OPC` command is received, this bit is set if all previous commands have been executed.
1	Not used

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

A.2.8 Operation Status Register

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

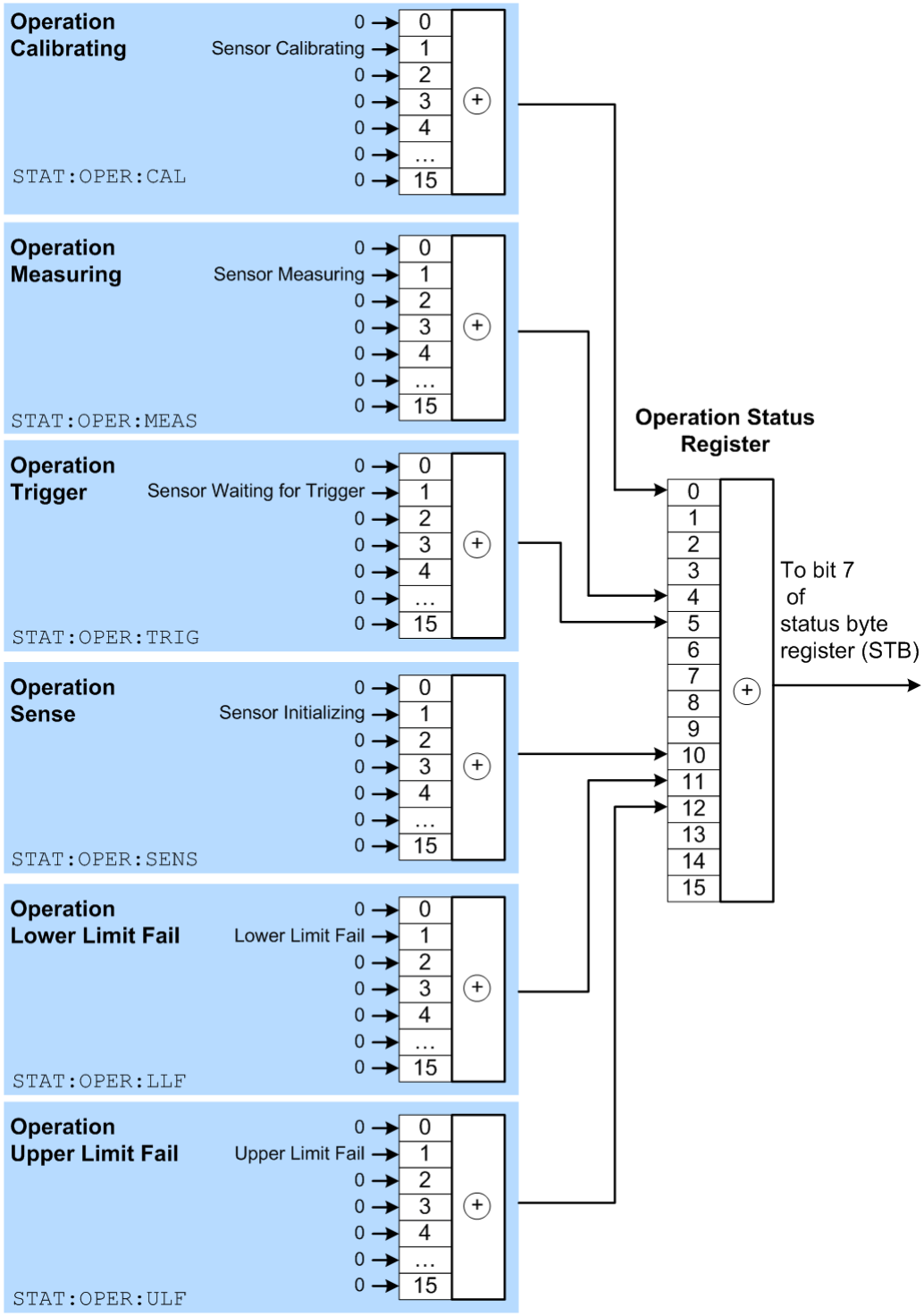
The register can be read by the queries:

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

Table A-7: Meaning of bits used in the Operation Status Register

Bit No.	Meaning
0	**Operation Calibrating Status Register summary bit** This bit is set if the sensor is being calibrated.
1 to 3	Not used
4	**Operation Measuring Status Register summary bit** This bit is set if the sensor is performing a measurement.
5	**Operation Trigger Status Register summary bit** This bit is set if the sensor is in the WAIT_FOR_TRG state, i.e. waiting for a trigger event.
6	Not used
7 to 9	Not used

Bit No.	Meaning
10	**Operation Sense Status Register summary bit** This bit is set if a sensor is initialized.
11	**Operation Lower Limit Fail Status Register** This bit is set if a displayed value has dropped below a lower limit value.
12	**Operation Upper Limit Fail Status Register** This bit is set if a displayed value has exceeded an upper limit value.
13 to 14	Not used
15	Bit 15 will never be used.



A.2.8.1 Operation Calibrating Status Register

The `CONDition` register contains information as to whether a sensor is currently being calibrated and, depending on the configuration of the transition register, the `EVENt`

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

The register can be read by the queries:

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

Table A-8: Meaning of bits used in the Operation Calibrating Status Register

Bit No.	Meaning
0	Not used
1	**Sensor calibrating** The sensor is being calibrated
5 to 15	Not used

A.2.8.2 Operation Measuring Status Register

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

The register can be read by the queries:

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

Table A-9: Meaning of bits used in the Operation Measuring Status Register

Bit No.	Meaning
0	Not used
1	**Sensor measuring** The sensor is performing a measurement.
5 to 15	Not used

A.2.8.3 Operation Trigger Status Register

The `CONDition` register contains information as to whether a sensor is currently in the WAIT_FOR_TRG state, i.e. expecting a trigger event and, depending on the configuration of the transition register, the`EVENt` register indicates whether the WAIT_FOR_TRG state was entered or quit by a sensor since the last readout of the register.

The register can be read by the queries:

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

Table A-10: Meaning of bits used in the Operation Trigger Status Register

Bit No.	Meaning
0	Not used
1	**Sensor waiting for trigger** The sensor is in the WAIT_FOR_TRG state and is waiting for a trigger event that will change it to the MEASURING state.
5 to 15	Not used

A.2.8.4 Operation Sense Status Register

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

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

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

The register can be read by the queries:

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

Table A-11: Meaning of bits used in the Operation Sense Status Register

Bit No.	Meaning
0	Not used
1	**Sensor initializing** The sensor is being initialized.
5 to 15	Not used

A.2.8.5 Operation Lower Limit Fail Status Register

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

The register can be read by the queries:

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

Table A-12: Meaning of bits used in the Operation Lower Limit Fail Status Register

Bit No.	Meaning
0	Not used
1	**Lower Limit Fail** The measured value drops below the lower limit value.
5 to 15	Not used

A.2.8.6 Operation Upper Limit Fail Status Register

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

The register can be read by the queries:

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

Table A-13: Meaning of bits used in the Operation Lower Limit Fail Status Register

Bit No.	Meaning
0	Not used
1	**Upper Limit Fail** The measured value exceeds the upper limit value.
5 to 15	Not used

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