ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

Power Meter

R&S NRP

1143.8500.02

Printed in the Federal
Republic of Germany

Tabbed Divider Overview

Data Sheet

Safety Instructions
Certificate of Quality
EU Certificate of Conformity
List of R&S Representatives

Tabbed Divider

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 2002-36

This is to certify that:

Equipment type	Stock No.	Designation
NRP	1143.8500.02	Power Meter
NRP-B1	1146.9008.02	Sensor Check Source
NRP-B2	1146.8801.02	Second Sensor Input
NRP-B5	1146.9608.02	3rd und 4th Sensor
NRP-B6	1146.9908.02	Rear-Panel Sensor
NRP-Z3	1146.7005.02	USB Adapter
NRP-Z4	1146.8001.02	USB Adapter
NRP-Z11	1138.3004.02	Average Power Sensor
NRP-Z21	1137.6000.02	Average Power Sensor

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

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN55011 : 1998 + A1 : 1999
EN61326 : 1997 + A1 : 1998 + A2 : 2001

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

Affixing the EC conformity mark as from 2002

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

Munich, 2002-06-27

Central Quality Management FS-QZ / Becker

Table of Contents

1 Putting into Operation

This Chapter describes putting into operation (unpacking, AC supply connection, switching the meter on and off), function testing and installing the meter, the preset or default settings and also contains front and rear views of the meter.

Notes on putting into operation

Before putting the R&S NRP into operation, ensure that

- the sensor inputs are not overloaded,
- the meter's outputs are not overloaded or wrongly connected,
- the ventilation holes are not obstructed.

The meter may be damaged if these precautions are not observed.

Unpacking the meter

When you have removed the meter from its packing, check that nothing is missing using the delivery note and the accessory lists.

If there is any damage, contact the carrier. Keep all the packing to support any claims for compensation.

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

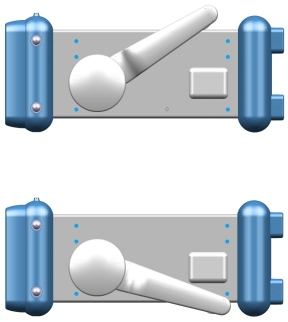
Setting up the meter

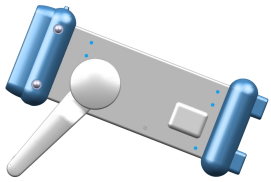
Carrying handle

If the R&S NRP is not installed in a rack, it should be set up so that the viewing angle for the display is optimal. The carrying handle can be locked in a variety of positions to act as a stand.

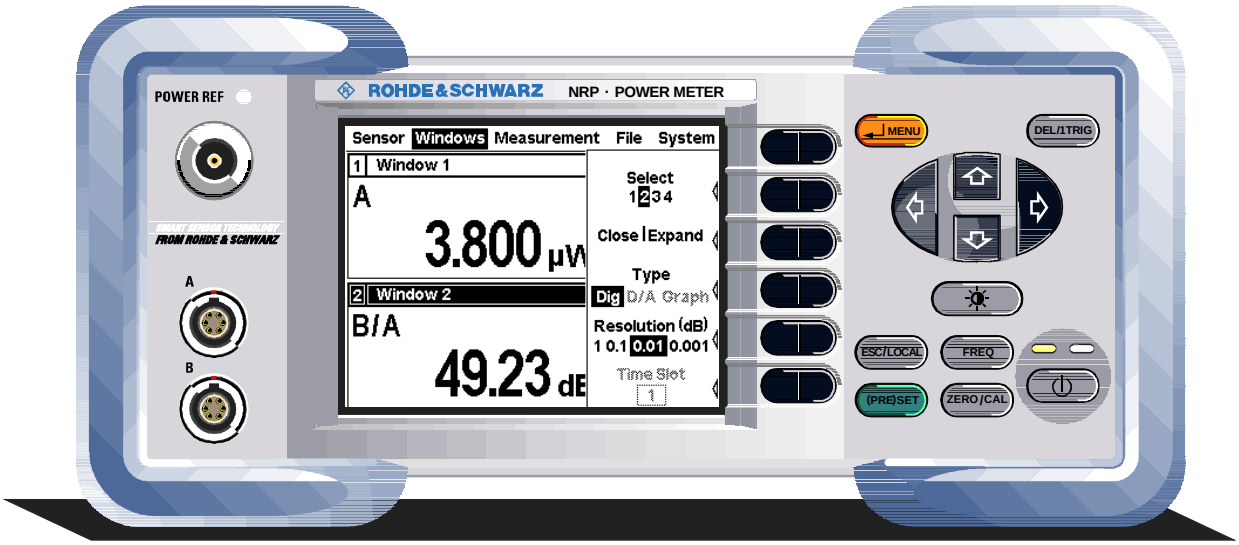
To adjust the handle, pull the two side-pieces of the handle outwards so that the handle can be rotated.

The handle locks at angles which are multiples of 60°.





Front and rear views



Front panel

Sensor connector

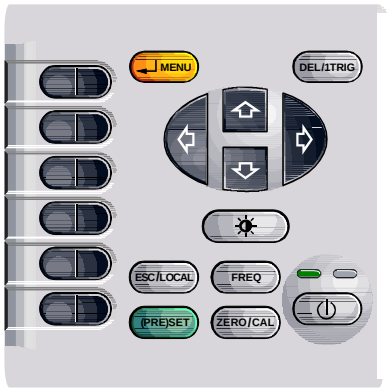
The front panel accommodates a maximum of two sensor connectors (for sensors **A** and **B**). The power sensors are connected by inserting the male connector. To disconnect hold the connector by its sleeve. Pulling on the sensor cable will not release the sensor connector.

Test generator

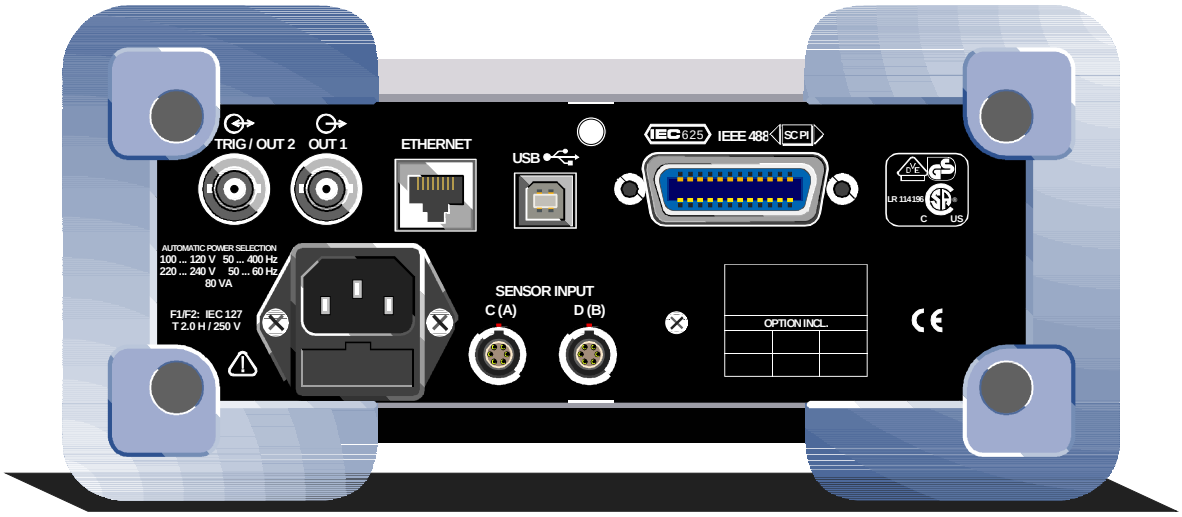
The test generator connector (option R&S NRP-B1) provides a high-precision, unmodulated sine signal with a power of 1 mW and a frequency of 50 MHz for checking the sensors.

The generator is turned on and off from the **System** menu (see Chapter 4.6 System Settings).

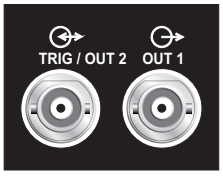
Keypad See Chapter 3 (Manual Operation).



Rear panel



OUT1 and TRIG / OUT2

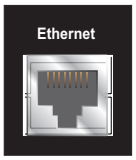


The BNC connector OUT1 outputs an analog signal with a voltage between 0V and 3.3 V. It can be used to output a voltage that is proportional to the measured value (e.g. for level regulation) or a digital signal for threshold monitoring.

The BNC connector TRIG / OUT2 can be used either as an external trigger input or as a second analog output.

The inputs/outputs are configured from the **System** menu (see Chapter 4.6 System Settings).

Ethernet

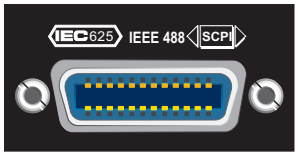


The Ethernet connector (option R&S NRP-B4) is an RJ45 socket for remote controlling the R&S NRP via a network.

USB

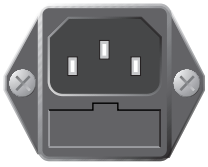
The type-B USB connector is used to update firmware by means of PC downloads (for more information, see the service manual, Chapter 4).

IEC/IEEE bus



The IEC/IEEE bus connector to IEEE488 is used to remote control the R&S NRP.

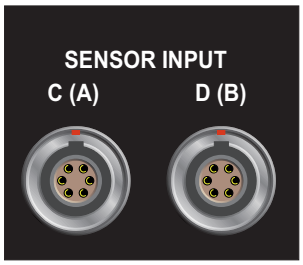
AC supply connector



The AC supply connector comprises a standard, IEC low-temperature connector and contains a fuse holder for two miniature fuses. The fuse holder can be taken out with a screwdriver.

See ☞ AC supply voltage on page 1.7 for more on connecting the AC supply.

Sensor connectors



Sensor connectors A and B (option R&S NRP-B6) or C and D (option R&S NRP-B5) can be accommodated on the rear panel.

Installation in a 19" rack

Caution

If the meter is rack-mounted ensure there is a free flow of air through the holes in the side panels.

The R&S NRP can be installed in 19" racks using a variety of rack adapters (see data sheet for order Nos.). The installation instructions come with the adapter.

AC supply voltage

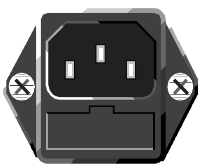
The R&S NRP can be operated from AC lines with a voltage range of 100 V to 240 V and a frequency range of 50 Hz to 60 Hz. Note that a restricted voltage range (100 V to 120 V) applies to 400 Hz networks. The AC supply connector is at the rear of the meter. The meter sets itself automatically to the applied voltage if it is in range.

AC supply fuses

The R&S NRP has two fuses as indicated by the type plate. The fuses are accommodated in a fuse holder in the AC supply connector. The holder can be pulled out to insert fuses. The power supply has its own fuse.

Caution

Only the service department may replace the internal fuse.



——— AC supply connector

——— Fuse holder

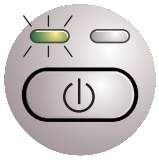
AC supply connector at the rear of the meter

EMC

To prevent EMI, the meter must always be installed to meet the relevant EMC standards. Never operate the instrument with its enclosure removed. Only use shielded signal and control cables that meet the relevant EMC standards.

Switching the meter on/off

ON/STANDBY key



⏻ key

The ON/STANDBY key is used to toggle between the *on* and *standby* states.

Yellow LED (AC supply)

The yellow LED indicates that the AC supply is connected to the R&S NRP.

Green LED (ON)

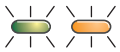
The green LED indicates when the meter is on.

The following are, therefore, the possible operating states:

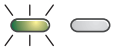
The meter is off and disconnected from the AC supply.

The meter is on standby. The AC supply is connected and the power supply is operating correctly.

If option R&S NRP-B3 (battery) has been installed, automatic charging will be started if the battery is low.



The meter is on and is being powered from the AC supply.

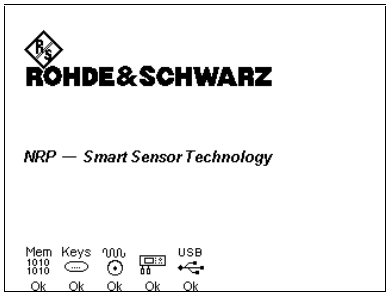


The meter is on and is being battery powered (only applies if option R&S NRP-B3 has been installed).

Caution

*If you want to completely isolate the meter from the AC supply, pull out the AC supply plug. Selecting the standby mode does **not** disconnect the AC supply.*

Welcome screen and function test



After switch-on, the R&S NRP performs a selftest. The contents of all non-volatile memories, the RAM and the addressability of all interfaces is checked. Messages indicate which options have been installed.

Function test on the RAM.

Addressability check on the interfaces for the sensor channels. Only one of the icons shown on the left is displayed to show the number of channels that have been installed.

Channel A.

Appears if the device is single-channel.

Channels A and B, fitted on the front panel.

Appears only if option R&S NRP-B2 is installed (second measurement input).

Channels A and B, fitted on the rear panel.

Appears only if option R&S NRP-B6 is installed at the rear (sensor connectors A (B)).

Channels A to D.

Appears only if option R&S NRP-B5 is installed (3rd and 4th measurement input).

Addressability check on the keypad controller.

Addressability check on the USB interface at the rear of the meter.

Addressability check on the test generator.

Appears only if option R&S NRP-B1 is installed. (test generator).

Addressability test on the Ethernet interface. The transmission rate is displayed.

Appears only if option R&S NRP-B4 is installed (Ethernet).

The “Ok” below the network icon indicates that the interface can be addressed.

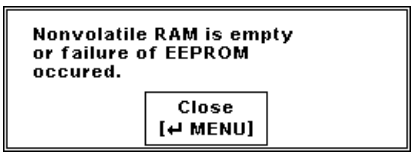
However, if a connection to a network hub is detected as booting continues, the Ok message is replaced by a message indicating the actual interface rate (10 or 100 Mbit/s).

If the R&S NRP is not connected to a network hub, or if it is not possible to set up a connection, NC (Not Connected) is displayed instead of the Ok message.

Addressability check on the battery and charging regulator.

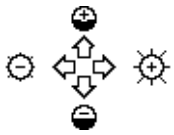
Appears only if option R&S NRP-B3 (battery) is installed.

If an error occurs when an interface test is being performed, the message *failed* is displayed under the appropriate icon and the icon is shown in inverse video. When all the tests are completed, booting is interrupted; booting can be restarted by pressing the **continue** softkey.



If an error is detected when the non-volatile memory containing instrument settings is checked, an error message is displayed when booting is completed. The non-volatile memory is then re-initialized completely and the R&S NRP goes into the preset state. All instrument settings that have been saved are lost as a result of this procedure.

Resetting and setting brightness and contrast



If you press the ◑ key immediately after switching on the R&S NRP, after about 3 seconds the R&S NRP goes into a state in which you can adjust brightness and contrast.

Initially, contrast and brightness are automatically set to their default values. You can then make the settings you want using the diagram on the screen.

ON state

Whenever the meter is switched off, its settings are saved. The next time it is switched on, these settings are automatically restored.

If the last setup before switch-off is to be restored, the R&S NRP must be switched off with the standby key ⏻. If the meter is turned off by disconnecting the AC supply, it is possible that the settings being used immediately beforehand are not saved.

Preset

When you press the (PRE)SET key, the R&S NRP goes into a well-defined preset or default state. If you press the **Preset** softkey in the dialog box that opens, the following parameters (amongst others) are set:

- All channels in the *Cont Av* mode (continuous average power).
- Absolute power measurement in dBm.
- One window per channel opened.
- Offset: 0 dB
- Automatic filtering (normal mode).

When the preset state is selected, all default parameters are set – even those for operating modes that have not been activated. See the section on preset hardkeys in Chapter 4.1 (Default Settings) for an explanation of the default settings.

Table of Contents

2 Getting Started

This Chapter contains step-by-step instructions for simple measurements and provides an introduction to the R&S NRP's basic modes of operation. Each step is listed in order. The operating steps that are to be performed are highlighted in grey, while the sections between contain screenshots and also comments and references to more information.

The five sections describe the following:

☞ Measuring average power	Step-by-step introduction to standard power measurements with the R&S NRP.
☞ Window handling (p. 2.11) and ☞ Setting measurement functions (p. 2.16)	Basic techniques for configuring measurement windows.
☞ Average burst power measurement using signal triggering (p. 2.18)	Steps for measuring average burst power without an external trigger.
☞ Measuring average power over defined time intervals (p. 2.20)	Simultaneous measurement of average power in one or more timeslots.

Some of the sections later on in this Chapter assume familiarity with the basic operating techniques which are introduced in the first two sections. It is, therefore, advisable to go through the first two sections before considering other topics.

Requirements

- Read the notes on putting the meter into operation in Chapter 1.
- A single-channel R&S NRP is sufficient for most of the examples used in the sequel. However, if you want to work through all the steps in the section ☞ Setting measurement functions (p. 2.16), you will need a dual-channel instrument.
- An R&S NRP-Z1x or R&S NRP-Z2x sensor is required for the section ☞ Measuring average power over a defined period (p. 2.20); all other sections can be worked through with the Thermal Sensors R&S NRP-Z5x.
- A signal source is required for the measurements that are described. It is best to use a signal generator whose level can be adjusted. If a generator of this type is not available, the R&S NRP's integral power reference (option R&S NRP-B1) can be used instead.

Measuring average power (Cont Av mode)

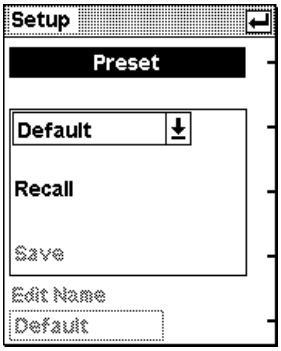
❶ Set the R&S NRP to the PRESET state.

The instrument is set to a well-defined initial state to prevent any previous settings from causing incorrect results.

➢ Put the R&S NRP into operation as described in Chapter 1 and connect a sensor to connector **A**.

(PRE)SET

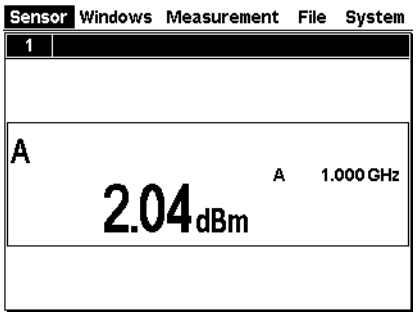
➢ Press the (PRE)SET key.



The Setup dialog box is displayed.

Preset –

➢ Press the Preset softkey.



The Setup dialog box disappears and the meter is in the preset state.

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

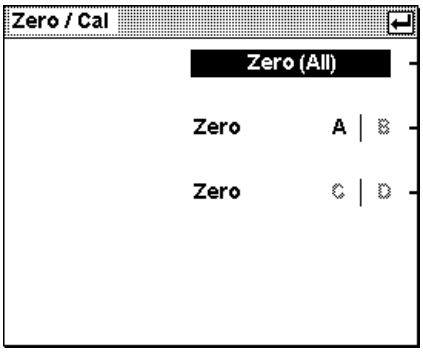
❷ Zeroing the meter

A zero error correction is one of the meter's default settings. This procedure should be repeated as and when necessary, but primarily when the sensor reaches its operating temperature.

- If the sensor is already connected to a signal source, disconnect it or turn the source off.

ZERO/TEST

- Press the ZERO/TEST key



The **Zero/Cal** dialog box is displayed.

Zero all –

- Press the **Zero all** softkey

The correction measurement takes several seconds. When completed a GO/NOGO message is output.

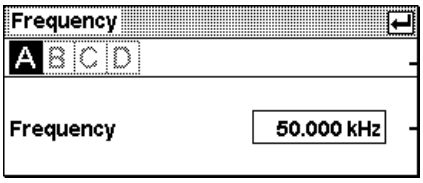
❸ Setting the frequency

The R&S NRP must be set to the carrier frequency of the applied signal if the specified measurement accuracy is to be reached.

- Connect an unmodulated signal with a level between –10 dBm and +10 dBm to the sensor.

FREQ

- Press the FREQ key



The Frequency dialog box is displayed.

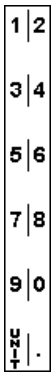
A | B | C | D –

- Select channel A by pressing the appropriate rocker switch.

Note: *If only one sensor (A) is connected, the tabs B, C and D are grey, i.e. channel A is selected automatically.*

Frequency – 

➢ Press the **Frequency** softkey



A panel with all the characters you will need to enter the frequency is displayed next to the softkeys.

1 2 3 4 5 6 7 8 9 0 U . – 

➢ Clear the field with the (Del) key

➢ Enter the frequency of the applied signal by pressing the appropriate softkey.

➢ Using the **UNIT** softkey select the unit you want.

✓ **Try the following:**

To familiarize yourself with the editor, try the following steps:

➢ Using the left/right cursor keys, move the block cursor and overwrite the digits with new values.

➢ Use the up/down cursor keys to scroll the digits to the cursor position.

➢ Move the insertion mark to the right onto the units. Select the unit with the up/down cursor keys.

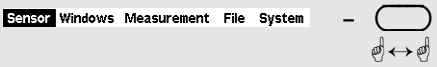
(↵ MENU)

➢ Confirm your entry.

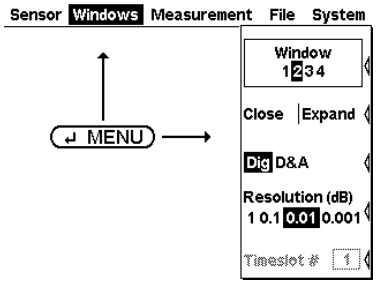
(↵ MENU)

➢ Close the dialog box.

❹ Setting the unit in the display

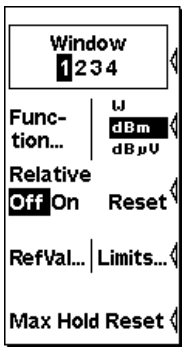


➢ Using the topmost rocker switch or the cursor keys (⇦⇨), select the **Measurement** menu.

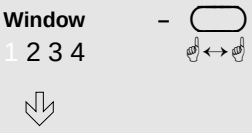


The menu opens out automatically for this procedure.

➢ Press the MENU key, if the menu is not displayed.



The results of post-processing are summarized in the **Measurement** menu.



➢ Use the **Window** softkey to select window 1.

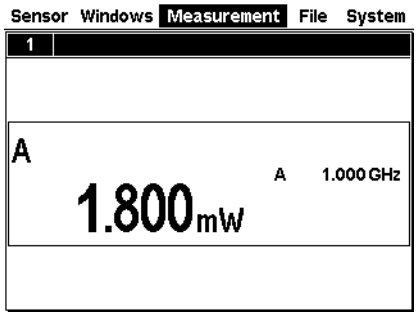
The functions in the **Windows** and **Measurement** menu are all defined for the selected window.

The dark title bar indicates the window that has been selected.

✓ **Tip:**

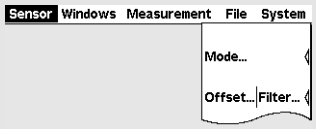
You can also select windows with the up/down cursor keys.

➢ Select **W** as the unit.



The result is displayed in W.

❺ Setting a fixed offset correction

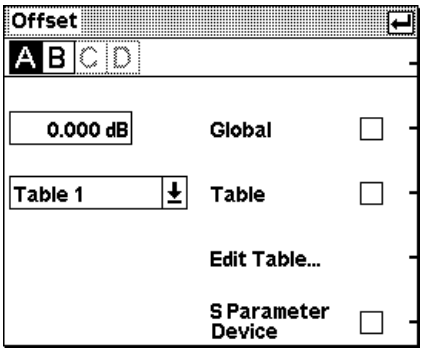


➢ Using the topmost rocker switch or the cursor keys (⇦⇨), select the **Sensor** menu.

All sensor-related settings can be made in the **Sensor** menu. This determines the type and details of data acquisition.

Offset... | Filter –

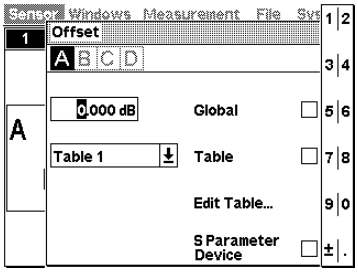
➢ Press the **Offset...** softkey (left-hand side of rocker-switch).



The Offset dialog box opens. Factors for correcting external signal losses or gains, due to an attenuator, for example, can be set in this box.

Global –

➢ Activate the editor for the global offset by pressing the left-hand side of the rocker switch next to **Global**.



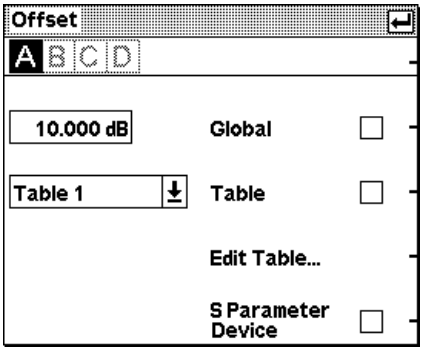
Positive values are for correcting losses and negative values for gains.

1 2 3 4 5 6 7 8 9 0 . –

➢ If you have an attenuator at hand, enter its value and connect the attenuator between the sensor and the signal source, otherwise just enter 10 dB.

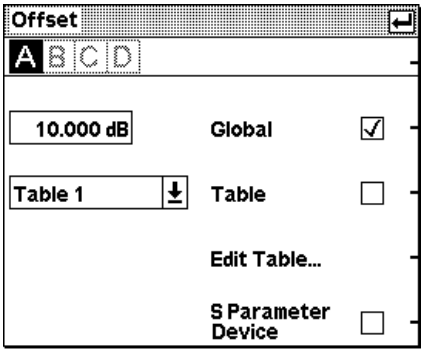
MENU

➢ Confirm the entry.



Global –

➢ Activate the global offset correction by pressing the right-hand side of the rocker switch next to **Global**.



Global offset correction is now on. The displayed value is increased or decreased depending on the sign of the offset.

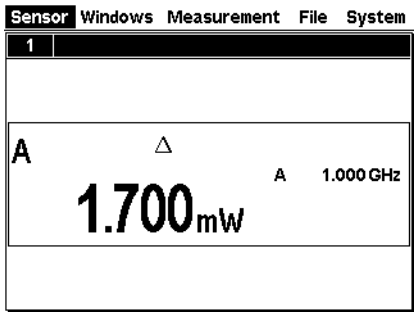
Factors which are not, or only minimally, dependent on frequency can be corrected in this way.

MENU

➢ Close the dialog box.

MENU

➢ Close the menu.

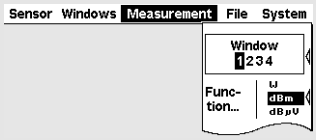


If you have connected an attenuator and entered its attenuation, the R&S NRP will display about the same value as before.

In the note line of the measurement window, the Δ symbol indicates that global offset correction has been activated.

❻ Relative power measurements

The R&S NRP can calculate and display the relative difference between a measured value and a reference value. The reference value can be a measured value that has been saved or an arbitrary value that is entered.



➢ Using the topmost rocker switch or the cursor keys (⇦⇨), select the **Measurement** menu.

Relative

➢ To activate the relative mode, press the right-hand side of the rocker switch next to **Relative**.

Relative
Off On Reset

As the default setup was loaded in step ❶, the value relative to 0 dBm is displayed.

Relative

➢ Press the rocker switch next to **Relative** again on the right-hand side.

Relative
Off On Reset

In the second line,

Off On

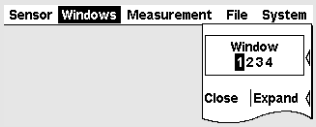
is displayed briefly and then the original display returns.

The last power result obtained has now been made the new reference value. If the power has not changed in the meantime, the reference value and the power are equal and the indicated value is 0 dB.

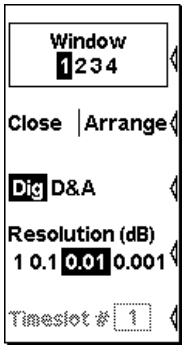
➢ If an attenuator is still connected, remove it now and connect the sensor directly to the signal source.

The displayed value should now equal the attenuation that has been entered.

❼ Checking settings (window zoom).



➢ Using the topmost rocker switch, or the cursor keys (⇦⇨), select the **Windows** menu



The **Windows** menu contains all the functions required for opening, closing and configuring windows.

Select – 1 2 3 4

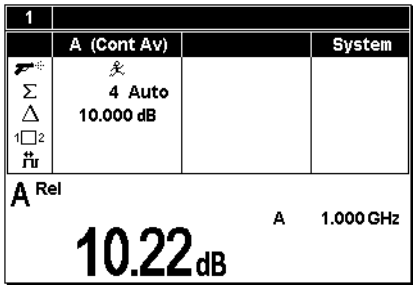
➢ Check if window 1 has been selected.

Close | **Expand** –

➢ Press the **Expand** softkey.

↵ MENU

➢ Close the menu.



Window 1 now expands to occupy the full space below the menu bar and displays all the key measurement parameters: The frequency from ❸, the offset correction from ❺ and the relative display from ❻.

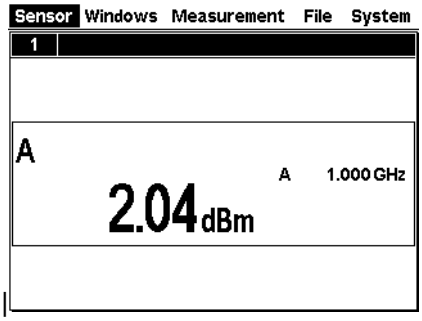
➢ To return the window to its normal size, open the **Windows** menu with the ↵ MENU key and press the **Arrange** softkey.

Window handling

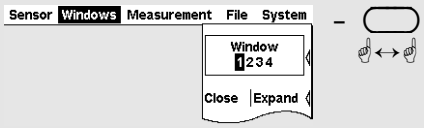
Up to four windows can be shown simultaneously on the R&S NRP's display. Each window can be configured for a separate measurement. The following examples show how to handle windows.

❶ Opening, creating, zooming and closing windows.

➢ Press the (PRE)SET key and then the Preset softkey.



A display window indicating the result from sensor A (in dBm) appears.



➢ Using the topmost rocker switch or the cursor keys (⇦⇨), select the **Windows** menu.

The **Windows** softkey can be used to select which window the functions in the **Windows** menu and in the **Measurement** menu will act on.

✓ **Tip**

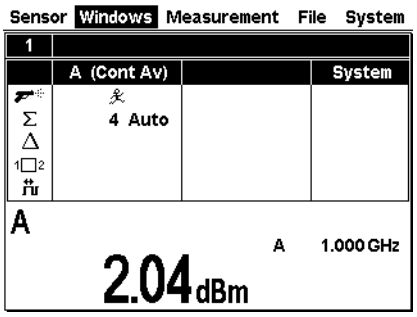
The cursor keys (↓) (↑) can, in most cases, be used instead of the rocker switch to select windows. This also applies to opened dialog boxes.

➢ Select window 1.

The third softkey is now labelled **Close | Expand**.

Close | **Expand** – 

➢ Press the Expand key



The window expands to occupy the full display height and indicates all parameters relevant to the measurement. The currently displayed values are the default values obtained after a preset.

Instead of **Expand,** the **Arrange** function is now available to arrange all opened windows.

Close | **Arrange** – 

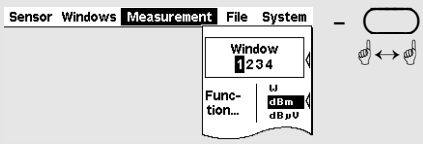
➢ Press the **Arrange** key.

Window 1 returns to its previous size.

The following steps show the difference between the **Open** and **Init** functions. You first have to change two settings of window 1.

Dig D/A – 

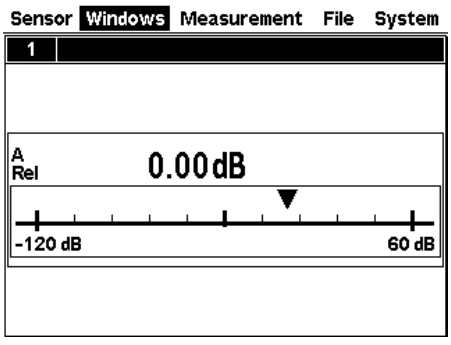
➢ Using the **Dig D/A** softkey, activate the analog display of results.



–

➢ Go to the **Measurement** menu and select **Relative On**.

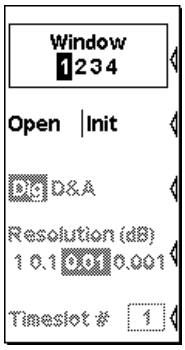
➢ Return to the **Windows** menu.



Window 1 now displays the **A Rel** function on an analog scale.

Close | Arrange – ⬭

➢ Now, close window 1 with the **Close** softkey.



"Select" in **Window** shows that window 1 is still selected.

The labelling next to the third softkey is now **Open | Init**.

Open | Init – ⬭

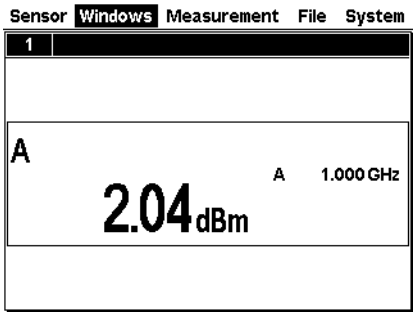
➢ Now, press the **Open** softkey (**not Init**).

The appearance of the window has not changed, and all window-specific settings have been maintained.

Close | Arrange – ⬭

Open | **Init** – ⬭

➢ Again close window 1 with **Close,** but open it this time with **Init**.



The window again displays the measurement function **A** in digital format.

The difference between **Open** and **Init** is that **Open** keeps the values of all the parameters that have been previously set in this window while **Init** sets all the parameters to their default values.

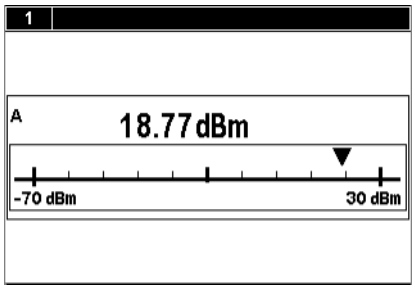
Caution: This function only resets the window settings made in the **Windows** *and* **Measurement** *menus, but it does not affect the sensor settings!*

❷ Display options

The **Type** softkey is used to select various display modes.

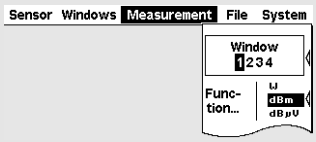
The standard display mode is **Dig**ital measured value.

Dig D/A Graph – ➢ Select the **D/A** display mode.



Window 1 now shows an analog scale and a digital reading.

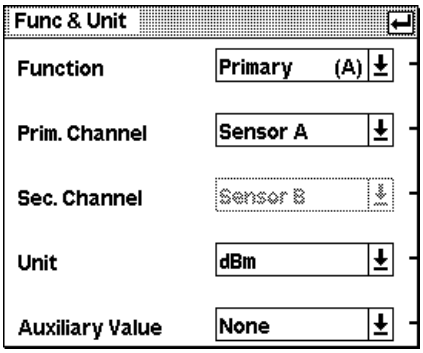
❸ Auxiliary values (Maximum, Minimum, Max, Min, ...).



➢ Select the **Measurement** menu.

Function...

➢ Select **Function...**in this menu.



The measurement function, unit, sensors used and the auxiliary value can be selected in the Function & Unit dialog box.

Auxiliary Value

➢ Open the **Auxiliary Value** drop-down list.

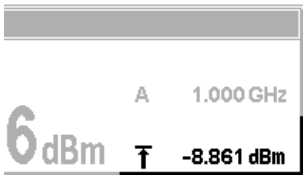
Auxiliary Value

➢ Select **Max**.

MENU

➢ Close the dialog box.

➢ Press the **Max Hold Reset** softkey and close the menu with MENU.



The updated maximum is now displayed on the right next to the measured value.

If you reduce the signal power, the maximum should remain the same. However, if the signal power is increased, the maximum changes accordingly.

Setting measurement functions

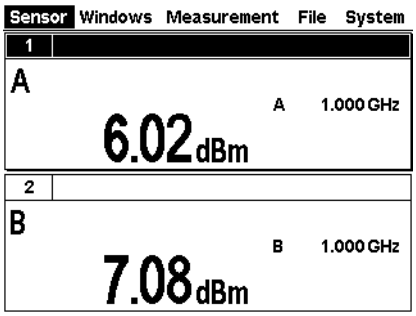
A multichannel meter with two sensors connected is required for this section. If only one sensor is available, you can only select the measurement functions "Primary" and "Secondary".

❶ **Measuring one power relative to another.**

(PRE)SET

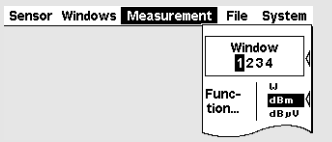
➢ Connect the two sensors to connectors A and B on the R&S NRP and apply an unmodulated signal with a level between –10 dBm and +10 dBm to each of the sensors.

➢ Press the (PRE)SET key and then the Preset soft-key.



Now, two display windows with the results (in dBm) from sensors A and B appear.

A window for each sensor is opened with Preset.

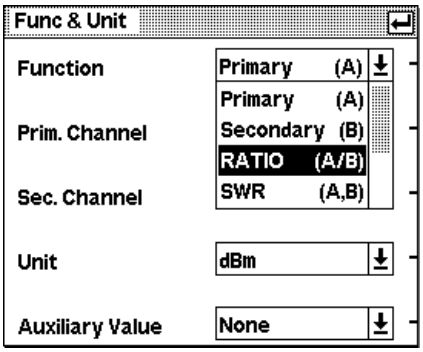


➢ Select the **Measurement** menu and then select **Function...** from this menu.

Function...

Function

➢ Open the **Function** drop-down list in the Function & Unit dialog box.



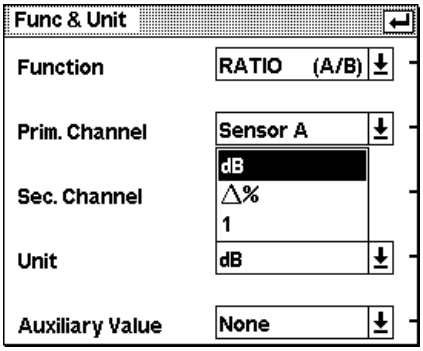
In this window, you can select the function which is used to calculate the result in the active window. **Ratio (A/B)**, for example, outputs the ratio of the power measured in channel **A** to the power measured in channel **B**.

➢ Check whether **Sensor A** is selected in the drop-down list for the primary channel and **Sensor B** in the drop-down list for the secondary channel.

✓ **Tip**
You can also operate the drop-down lists by means of the cursor keys (↓) (↑) instead of the rocker switch.

Function – ➢ Select **Ratio (A/B)** from the drop-down list for the measurement function and close the drop-down list with (↵ MENU).

Unit – ➢ Now, press the **Unit** softkey.



The ratio of two powers is dimensionless – this is why only **dB**, **Δ%** and **1** are available in the unit list. The symbol **Δ%** represents the relative uncertainty in % (0% means the powers in both channels are equal), the symbol **1** represents a straight ratio, i.e. not the log of a ratio.

Measuring av. burst power with signal trig. (Burst Av mode)

An R&S NRP-Z1x or R&S NRP-Z2x diode sensor is required for this section. A pulsed RF signal is also needed to perform the measurements.

The R&S NRP-Z1x and R&S NRP-Z2x sensors have two measurement modes for RF burst power: Burst Av and Timeslot.

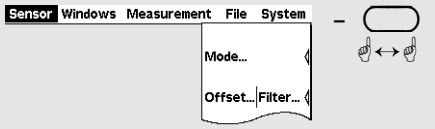
An external trigger is not required in the *Burst Av* mode – the sensor automatically determines the trigger point from the measured signal. It is also not necessary to specify the width of the burst as the sensor determines the end of the burst automatically.

❶ Setting the burst mode.

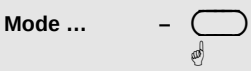
➢ Connect an R&S NRP-Z1x or R&S NRP-Z2x sensor to connector A on the R&S NRP and apply a pulsed signal with a level between –10 dBm and +10 dBm.

➢ Press the (PRE)SET key and then the **Preset** softkey.

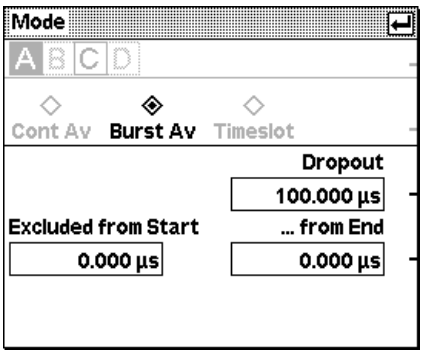
A measurement window is now available.



➢ Select the **Sensor** menu and then select the **Mode** item in this menu.



➢ Select the **Burst Av** mode.



The burst mode parameters are displayed at the bottom of the dialog box.

As there is usually no point in measuring the initial and final pulse transients, they can be excluded with the parameters **Excluded from Start** and **Excluded from End**.

The parameter **Dropout** helps to ensure the reliable detection of the end of modulated-signal bursts (e.g. NADC).

See Chapter 4, Measuring the average burst power, for a detailed description.

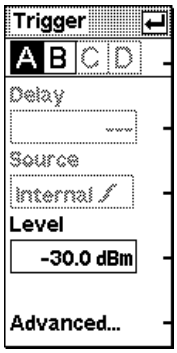
❷ Settings to ensure reliable triggering

MENU

➢ Close the **Mode** dialog box.

Trigger ... –

➢ Now, open the **Trigger** dialog box.

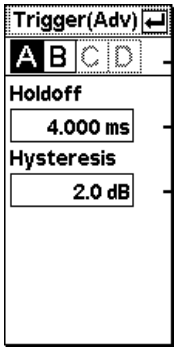


➢ Level

Set the trigger threshold in this box.

Advanced ... –

➢ Now, open the **Advanced** dialog box from the **Trigger** dialog box.



In the **Advanced Trigger** dialog box, the parameters **Holdoff** and **Hysteresis** can be used to ensure reliable triggering – even when difficult signals are involved.

➢ **Holdoff**

For specifying a time interval (measured from the start of the detected burst) in which no further burst starts are to be detected.

➢ **Hysteresis**

The effect of setting a trigger hysteresis which is not equal to 0 dB is that the measurement level must be under the trigger threshold by at least this amount, if triggering is to occur again. In the case of burst signals, trigger hysteresis is not critical and this is why any value between 0 and 3 dB can be selected.

See Chapter 4, Trigger Settings, for a detailed description of these parameters.

Measuring average power in a specific timeslot (Timeslot mode)

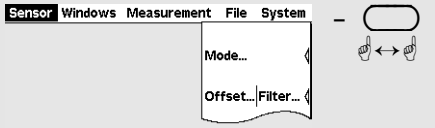
The *Timeslot* mode is used to measure the average power in a specific time of any complex signal. Usually, an external trigger is used. This ensures that triggering is always reliable and it is possible to measure very low powers. For example, it is possible to simultaneously perform measurements in one or more TDMA timeslots.

❶ Setting the timeslot mode.

(PRE)SET

- Connect an R&S NRP-Z1x or R&S NRP-Z2x sensor to connector A on the R&S NRP and apply a pulsed signal with a level between –10 dBm and +10 dBm.
- Press the (PRE)SET key and then the **Preset** softkey.

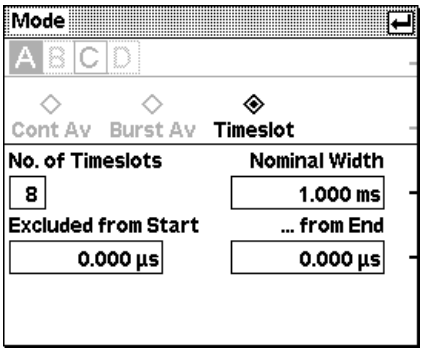
A measurement window is now available.



Mode ...

Cont Av Burst Av **Timeslot**

- Select the **Sensor** menu and then select the **Mode** item in this menu
- Then select the **Timeslot** mode.



The associated parameters are displayed at the bottom of the dialog box.

- Set the length of the time interval of interest or the nominal timeslot width as the **Nominal Width**.
- Using **Excluded from Start** and **Excluded from End** define the sections of the timeslot that are to be excluded from the measurement.
- The parameter **No. of Timeslots** specifies the number of consecutive timeslots on which simultaneous measurements are to be made. In this example, the number is 1.

See Chapter 4, Triggered measurements in timeslots, for a detailed description.

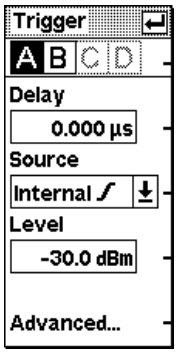
❷ Setting timeslot trigger parameters.

MENU

➢ Close the **Mode** dialog box.

Trigger ... –

➢ Now, open the **Trigger** dialog box.



The following trigger parameters are provided in the Timeslot mode:

➢ **Source** (trigger source)

You can either select external triggering (via connector I/O2 on the rear panel) or internal triggering (derived from the signal) on the positive or negative slope.

Note: Because of the double assignment of I/O2 as the trigger input or the analog output, ensure that the setting in Dialog System→IO is correct!

➢ **Delay**

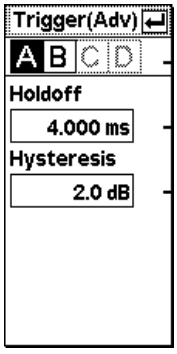
For defining the start of Timeslot 1 with respect to the trigger edge. The value can be positive or negative.

➢ **Level**

For setting the trigger threshold for the **Internal** trigger source.

Advanced ... –

➢ Now, open the **Advanced** dialog box.

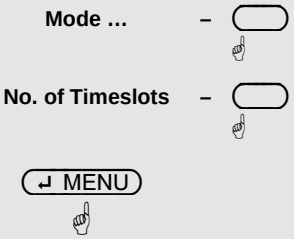


The setting in this dialog box ensures reliable triggering on a number of possible trigger events.

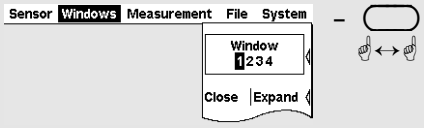
See Chapter 4, Trigger Settings, for a detailed description of these parameters.

❸ Simultaneous measurements in several timeslots.

To perform simultaneous average power measurements in several timeslots in a frame of a TDMA signal, you need an external trigger signal that is synchronized with the start of the frame.



- Apply an RF signal with a TDMA structure and a level between –10 dBm and +10 dBm to the sensor.
- Set the timeslot and trigger parameters as described in sections ❶ and ❷ as appropriate for the signal.
- Open the **Mode** dialog box.
- Enter the number of timeslots in a frame – e.g. 8 for GSM – and close the **Mode** dialog box.



- Select the **Windows** menu.
- Use the rocker switch next to **Timeslot #** to display the measured values associated with the various timeslots in the measurement window.

✓ **Tip**

You can also open a separate window for each timeslot. Up to four timeslot results can be displayed simultaneously in this way.

Table of Contents

3 Manual Operation

This Chapter describes the controls, displays, etc, the screen layout and how to operate the R&S NRP.

Keys

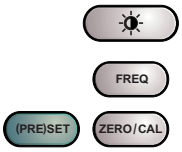
Keys on the front panel of the meter are used to manually operate the instrument. There are several groups of keys, each group having a different function:

Softkeys

The six softkeys are rocker switches – in other words, they can be “rocked” backwards and forwards by pressing on the right or left side of the key.
The softkey function is context-sensitive and is indicated by screen labelling.

For more information on the softkeys see ☞ Menu handling on p. 3.7 and ☞ Dialog boxes and their control elements on p. 3.8.

Hardkeys

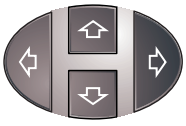


The hardkeys are a direct way of activating the main functions and are always available for use:

- Brightness/contrast
- Frequency entry
- Preset and setups
- Zeroing

See Chapter 4.1, Default settings, for more information on hardkeys.

Cursor keypad



The cursor-key functions are context-sensitive. They can be used to

- Select the menu,
- Select the active window,
- Move the cursor in text boxes,
- Change the value of an entry in a text box,
- Select an element from a drop-down list,
- Adjust the brightness and contrast of the display.

With the exception of moving the cursor, the functions referred to above can also be activated using softkeys.

Enter / MENU key

As the (↵) key (i.e. Enter key), it is used to confirm entries in text fields and dialog boxes and to confirm selections in the drop-down lists.

As the (MENU) key, it is used to fold out and fold back the menus next to the softkeys.

The function of the key is determined according to context – in other words, the Enter or MENU function is always selected automatically for the operator by the instrument.

ESC / LOCAL

This key is used as an (ESC) key to escape from the entry mode in text boxes and drop-down lists. It is also used to close dialog boxes and menus without losing any entries that have been made (☞ Title bar on p. 3.8).

As the (LOCAL) key, it is used to switch the R&S NRP from remote control mode (all controls disabled) to manual mode.

The key is automatically assigned its function according to context – in other words, there is no manual assignment by the operator.

DEL / 1 TRIG

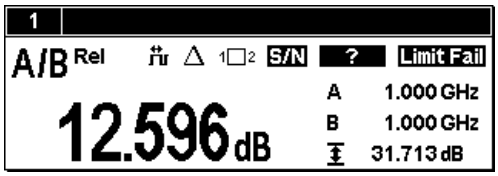
The (DEL) key is used to delete numbers or text in a field so that a completely new entry can be made.

As the (1 TRIG) key, it triggers single-shot measurements in the Scope mode.

The function of the key is selected automatically according to context.

Screen layout

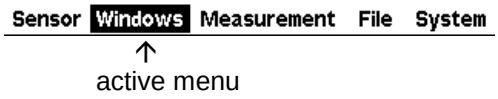
Window



The R&S NRP displays results in windows. A maximum of four windows can be displayed simultaneously on the screen. They are numbered 1 to 4. Windows have a title bar which contains the number (not user-assignable) and a name (user-selectable) for the window.

Windows do not have any control elements.

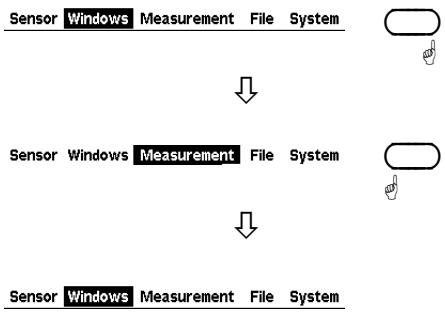
Menu bar



A menu bar is always displayed at the top of the screen. It contains the names of the R&S NRP's menus.

One of these names is always in inverse video and this is the name of the active menu.

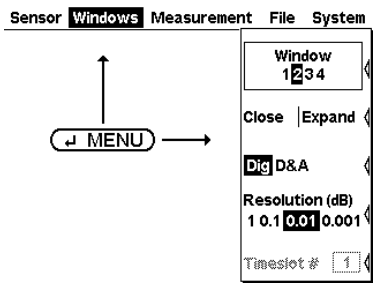
Menu selection



The menu you want to activate can be selected by pressing the right- or left-hand side of the topmost rocker switch one or more times.

Alternatively you can also use the cursor keys (→) (←).

Folding menus out or back



(↵ MENU) folds out the active menu.

The usual PC convention is not followed – instead of dropping down directly below the menu name in the menu bar, menus fold out to the right-hand edge of the screen. This means that the menu items are directly next to the rocker switches used to select them.

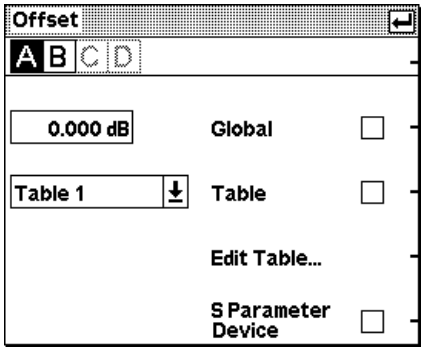
If you press the (↵ MENU) key again, the menu folds back.

The menu also folds out automatically if another menu is selected.

Menus

See p. 3.7, ☞ Menu handling for more information.

Dialog boxes



Dialog boxes can be opened from the menus. The dialog boxes present a group of related parameters that can be set.

See ☞ Dialog boxes on p. 3.8 for more information on handling dialog boxes.

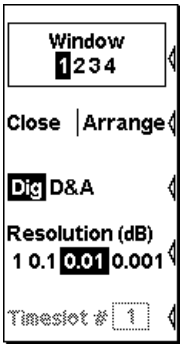
Menu layout

Sensor

All sensor settings can be made using the **Sensor** menu. The type and details of data acquisition can be specified with this menu.

See Chapter 4.2, Data acquisition and parameters, for a detailed description.

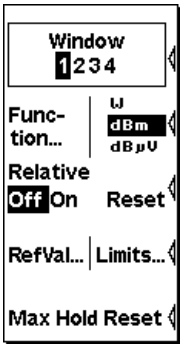
Windows



The **Windows** menu is used to configure windows and the result display in the windows.

See Chapter 4.3, Displaying measurement results, for a detailed description.

Measurement



The details of postprocessing are summarized in the **Measurement** menu.

See Chapter 4.4, Configuring measurements, for a detailed description.

File

The **File** menu is used to handle the setup memories and display information about the instrument and any sensors that have been connected.

See Chapter 4.5, Management of settings, for a detailed description.

System

The **System** menu is used to handle functions that are not specifically used to perform measurements.

See Chapter 4.6, System settings, for a detailed description.

Menu handling

The menus can contain up to eight menu items which are used to perform an action, open a dialog box or set a parameter.

Perform action

If the menu contains only one or two descriptive terms, an action is performed directly.

Close

Open dialog box

If a menu item is followed by three dots "**...**", it can be used to open a dialog box to set a variety of parameters.

Mode...

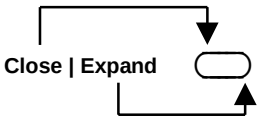
Set parameters

Parameter-setting options are presented in the menu. The currently selected option is shown in inverse video. You can select the option you want by pressing the left or right side of the rocker switch.

Relative
On Reset

Softkeys with dual assignments

Some softkeys are assigned two menu items. One is selected by pressing the left-hand side of the rocker switch, the other, the right-hand side.

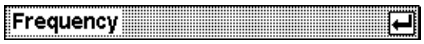


The two menu items are separated by a vertical line.

Dialog boxes and their controls

Dialog boxes contain check boxes, option fields, editing fields and drop-down lists as control elements. They are activated using the appropriate rocker switch to their right. If two control elements are positioned side by side, the element on the left is operated with the left-hand side of the rocker switch and the element on the right with the right-hand side of the rocker switch.

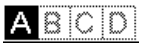
Title bar



Dialog boxes have a title bar which displays the name of the dialog box and the ↵ symbol which is a reminder that the dialog box can be closed with the (↵ MENU) key.

Caution: Settings made in dialog boxes are immediately set on the R&S NRP – in other words you do not need to close the dialog box to activate the settings in the box.

Dialog boxes with tabs



Channel-specific settings are made in a special page in a super-ordinate dialog box. In the top row of the dialog box, there are tabs which you can use to switch between pages.

Channels which do not have a sensor connected and channels that have not been installed are shown in grey and cannot be selected.

Check boxes

Check boxes are used to activate and de-activate functions. You can toggle between the two states by pressing the appropriate softkey.

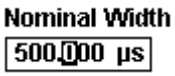
Option fields

Option fields contain groups of mutually exclusive operating modes.

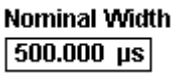
When you press the left-hand side of the rocker switch, the next option on the left is selected. When you press the right-hand side of the rocker switch, the next option on the right is selected.

In the **System I/O** dialog box, option fields are assigned to only one side of a rocker switch. It is therefore only possible to scroll through in one direction.

Editing fields



Entry active



Not active

Editing fields are used to enter or modify numbers and text. The editor is activated by pressing the appropriate rocker switch — or the appropriate side of the rocker switch if there is a dual assignment.

Editing can be performed in overwrite mode, indicated by the marked character being in inverse video. Modifications can be made either with the (↓) (↑) cursor keys or numeric/digit softkeys which are provided in a digit or letter panel when the editor is activated.

The (→) (←) cursor keys are used to select the digit to be edited.

Editing fields (cont.)

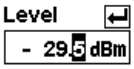
In the editing fields for quantities with units, the left/right cursor keys can be used to select the unit too; the up/down cursor keys are used to edit it. Usually, the digit panel also contains a unit softkey which you can use to change the unit whenever you want.

If you want to make a completely new entry, the whole field can be cleared with the (DEL/1TRIG) key. In the insert mode (indicated by the I cursor), you can enter digits and/or letters.

Any changes you make to a field can be confirmed with the (↵ MENU) key. When this key is pressed, the new value is subjected to a validity check. If the check discovers an error, a warning message is output.

You can quit the editor by pressing the (ESC) key; this leaves the old values unchanged. Any warning messages are cleared.

Editing fields with direct entry of values

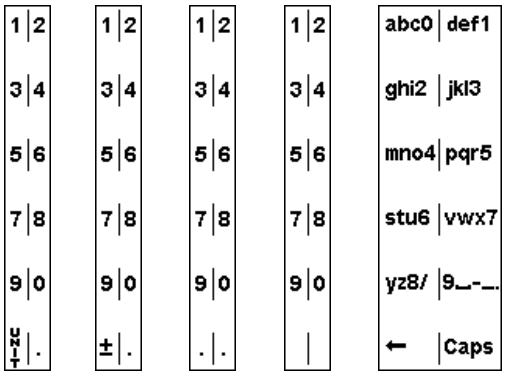


The Filter, Range, Trigger and Trigger Advanced dialog boxes are designed such that you can read the values even when the dialog box is open.

If you edit a value in a dialog box using the cursor keys (↓) (↑), the new value is accepted immediately when you press a key. This feature allows you to quickly assess the effect of editing and to perform interactive adjustment.

If you enter a new value with the letter panel (see below), however, the symbol ↵ appears above the editing field to indicate that the new value is not accepted until you confirm it with the (↵ MENU) key.

Digit and letter panels

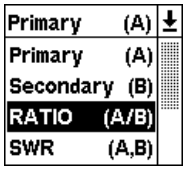


Panels which are displayed when an editing field is activated (see above) are used to enter digits, letters and units.

Entering letters with the letter panel is like entering letters on a phone keypad. The Caps key is used to select upper case for the next letter.

Caution! *To edit the Trigger Delay, you must select the unit by means of the cursor keys (see above).*

Drop-down lists



Drop-down lists are used to select an item from an “a la carte” list. When the drop-down list is activated, the list “folds out” upwards or downwards.

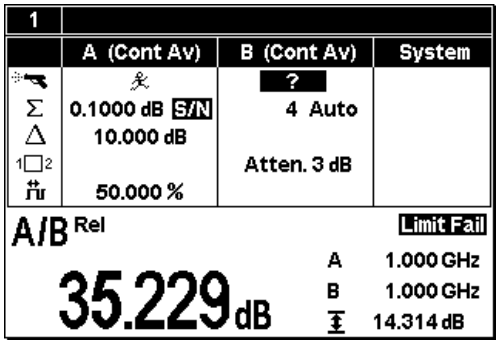
The up/down cursor keys, or one of the rocker switches next to the list, are used to select items from folded out pop-up menus. Confirm the selection with the (↵ MENU) key or reject with the (ESC) key.

Display windows

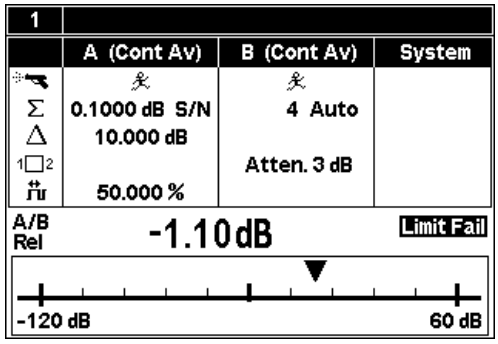
Window sizes and types

Results are displayed in the main section of the screen in windows. Windows come in three sizes: half height, quarter height and full height. In windows, values can be displayed digitally or in a combined digital and analog mode (See Chapter 4.3, Displaying measurement results, for instructions on selecting these modes).

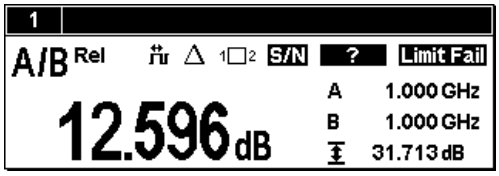
DIG window, full height



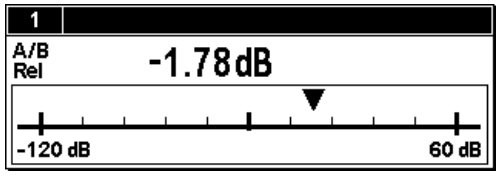
Analog window, full height



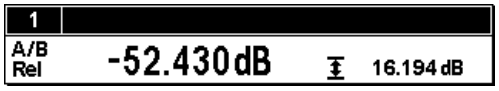
DIG window, half height



Analog window, half height



DIG window, quarter height



Analog window, quarter height

You can expand all opened windows to full height by activating the **Expand** function from the **Windows** menu. In this state, the full-height windows can be displayed consecutively using the **Window 1 3 4** menu item. The opened windows can be reduced to their previous sizes with the **Arrange** menu item. Otherwise, it is not possible to change the size of the windows – the window size is determined by the number of windows.

Special symbols

The Table below shows what each symbol means:

Window symbols	
1	Window number
Window 1	Window name
↵	Close box, operated with the (↵ MENU) key

Measurement function	
A/B	Measurement function
Rel	Relative measurement mode ON

Correction functions	
⎍	Duty cycle correction ON
△	Offset correction ON
1□2	Twoport correction ON (S-parameter device)

Filter	
Σ	Averaging filter
4 Auto 64 Man	Filter size with auto-filter (normal mode) or for manual mode
0.1000 dB S/N	Fixed noise auto-filter
S/N	Noise ratio exceeded

Other	
	Battery level indicator
	Battery charging
Limit Fail	Over limit

Display values	
A 1.000 GHz B 1.000 GHz	Frequency in the primary and secondary channel
14.314 dB	Auxiliary value

Auxiliary value symbol	
	Max-Min
	Max
	Min
+/-	Measurement uncertainty
2σ	Noise

Trigger symbols	
	Trigger
	Free-running trigger
?	Trigger remains OFF
1TRIG	Single-shot mode, trigger expected
1TRIG	Single-shot mode, measurement over
A B C D Ext	Trigger source (channel A, B, C, D or external)
	Trigger on rising slope
	Trigger on falling slope

Table of Contents

Figs.

4 Instrument Functions

This Chapter contains a systematic description of the R&S NRP's functions in the order in which they occur in the menus.

The grey text in the headings provides additional information that should prove helpful.

- Hardkeys for opening dialog boxes: ---------- TASTE
- Menu items which directly perform an operation when selected: --------- Menu→menu item
- Menu items that open dialog boxes: ---------- Menu→menu item…
- Dialog-box elements: ---------- Dialog: Dialog element

The symbols in the left-hand column of the description indicate the following:

Sensor menu:		Context in which the operation below can be performed.
Mode dialog:		
Name	–	Softkey (menu item or dialog element)
TASTE		Hardkey
	–	Function is activated with the left-hand side of the rocker switch.
	–	Function is activated with the right-hand side of the rocker switch.
	–	Function can be activated with either side of the rocker switch.
	– ↔	Selection function (change direction by pressing the other side of the rocker switch)
		Action arrow
Action	⇨	Result

Default settings

Hardkeys can be used to obtain the functions for the default settings for any measurement.

Stored settings

(PRE)SET

When (PRE)SET is pressed, the instrument is set to its default state (preset) or to one of 10 user-definable setups.

Hardkey

(PRE)SET

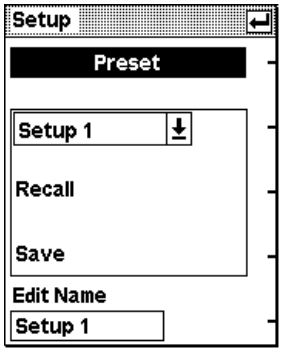


Fig. 4-1 Setup dialog box

Preset – Sets the R&S NRP to its default settings (preset).

Setup – For selecting a setup that can be acted on by the functions *Recall*, *Save* or *Edit Name*.

Recall – Recalls the selected setup. The message "**... done**" is displayed when loading has been successfully completed.

Save – Saves the current setup under the name you have selected. The message "**... done**" is displayed when saving has been successfully completed.

Edit Name – For editing the name of the setup you have selected.

Frequency settings

FREQ

FREQ is used to set the carrier frequency of the applied signal. This corrects any frequency-dependent effects introduced by the sensor.

If the sensor is to reach the specified measurement accuracy, a frequency entry must be made.

Hardkey

FREQ

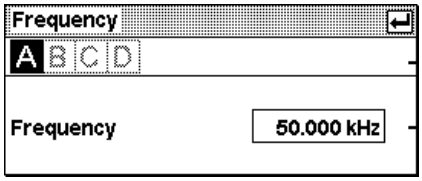


Fig. 4-2 Frequency dialog box

A | B | C | D – ↔

Tabs for selecting the sensor.

Frequency –

Field for frequency entries with the units kHz, MHz or GHz.

Zeroing

ZERO/TEST

ZERO/TEST starts the autozero function or a test to check the confidence level of sensor results.

Hardkey

ZERO/TEST

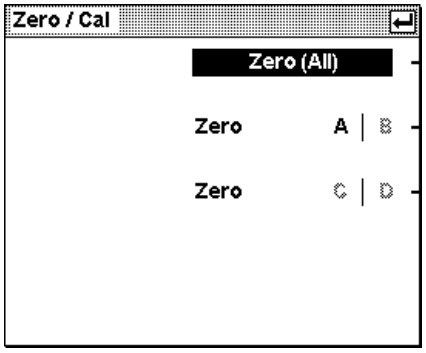


Fig. 4-3 Zero/test dialog box

Zero All –

Zeroes all connected sensors.

Caution

Turn off all test signals before zeroing.

Zero A | B –

Starts zeroing in channel A.

Zero A | **B**

Zero C | D

Zero C | **D**

Zeroing for channels B, C and D.

Zeroing failure

If a power level outside the permissible range is measured during zeroing, the R&S NRP outputs an error message. The most common cause of this error is that the user started zeroing without turning off the test signal beforehand. Otherwise the sensor probably has a hardware defect.

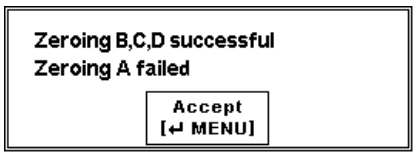


Fig. 4-4 Zeroing error message

Contrast and brightness

Hardkey

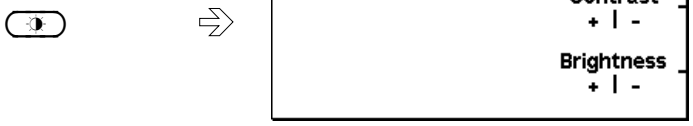


Fig. 4-5 Display dialog box

Contrast – Sets the display contrast.

Brightness – Sets the display brightness.

Data acquisition and parameters

Sensor - menu

Depending on the options that have been installed, up to four sensors can be connected to the R&S NRP. The sensors perform the complete power measurement from the acquisition of the RF signal to every aspect of result processing. All parameters for configuring data acquisition are entered in the Sensor menu. Some of the parameters listed below are not available for certain types of sensor.

The Sensor menu contains the following items:

- ☞ Setting the measurement mode, page 4.5.
- ☞ Offset correct, page 4.13 and ☞ Filter / averaging, page 4.15.
- ☞ Measurement ranges, page 4.18.
- ☞ Effect of the RF source, page 4.19.
- ☞ Trigger settings, page 4.20.

Fig. 4-6 Sensor menu

Setting the measurement mode

Sensor→Mode…

The measurement mode is selected and configured in the Mode dialog box. In addition to the *Cont Av* mode, there are further measurement modes for the various sensor types available. For more information, see the operating manual for the sensor in question.

Sensor menu:

Mode… –⬭ ⇨

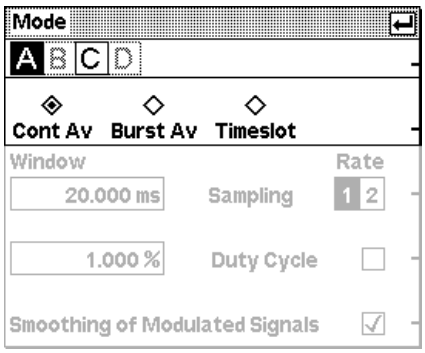


Fig. 4-7 Mode dialog box

A | B | C | D –⬭ ↔ Tabs for sensor selection.

Cont Av, Burst… –⬭ ↔ Measurement modes.

In the Continuous Average mode, the average signal power is continuously measured without the window and signal being in sync. (☞ Free-running average-power , page 4.6)

The Burst Average mode is for measuring the average burst power of pulsed signals. (☞ Measuring the average burst power, page 4.9).

In the Timeslot mode, the average power can be measured over any interval of a periodic signal. In this mode, measurements can also be

made simultaneously in several TDMA-signal timeslots. (☞ Measuring average power , page 4.11).

Free-running average-power measurements

Mode : Cont Av

The Continuous Average mode is the preferred measurement method if the measurement is not to be, or cannot be, synchronized with a specific signal event.

This is the only available measurement mode for thermal sensors because they are too slow for the other measurement modes.

Mode dialog box:

Cont Av, Burst... – ⬭ ↔ ⇨

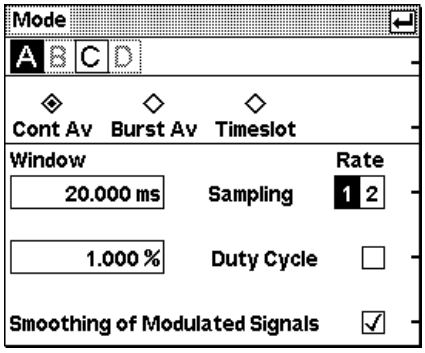


Fig. 4-8 Mode dialog box, Normal mode

Sampling Window – ⬭

This parameter defines the duration of the measurement window for sensors with sampling A/D converters. In the manual mode, the default setting of 20 ms combined with smoothing (see below) is usually adequate. Another value, generally larger, is essential if the result exhibits fluctuations due to modulation. With very low frequency modulation in particular, it is a good idea to set the size of the sampling window so that it exactly equals the modulation period, so ensuring optimal display settling:

		Optimal sampling-window size
Smoothing	Off	N × modulation period / 2
	On	N × modulation period × 2

N = 1, 2, 3, …

This means that the minimum theoretical measurement time can only be obtained with smoothing turned off.

The more modulation periods fit into a sampling window, the less critical it is whether N is an integer or not. With smoothing on, about five periods are enough to reduce fluctuations caused by modulation to an acceptable level – even if N is not an integer. With more than nine periods, the fluctuations are imperceptible. With smoothing off, the situation is much less favourable as instead of just five periods as many as 300 are required; the fluctuations only completely disappear with more than 3000 periods.

However, it is not advisable to make the sampling window too wide by selecting an excessively large N, as the intrinsic noise of the sensor increases. To reduce display fluctuations due to noise, it is best to use the averaging filter. (☞ Filter / averaging, page 4.15)

For more information, see ☞ Background information, page 4.8.

Integration Time – ⬭

This parameter defines the size of the measurement window for thermal sensors. This type of sensor uses integrating sigma-delta converters with a high conversion rate (approx. 2×10^4/s) instead of sampling A/D converters. However, this type of sensor processes these digital values like the sampling A/D converter so that the user does not notice any difference in the size of the sampling window when it comes to the reduction of reading fluctuations due to modulation or the selection of the shortest measurement times (☞ Sampling Window, ☞ Smoothing…).

Sampling Rate – ⬭

If a sensor contains a sampling A/D converter, the sampling rate can be adjusted to prevent aliasing effects for particular types of modulation signal. Aliasing can occur when certain types of sensor are used because the sampling frequency is close to the video bandwidth and components from the modulation frequency spectrum may fall within this frequency range. Changing the sampling rate will make the aliasing effects disappear.

Duty Cycle – ⬭

Using the duty cycle correction, the average power of RF bursts can be calculated from the average power of the whole signal. The average power of the whole signal is divided by the duty cycle of the signal.

If thermal sensors are used, this is the only way of determining burst power.

If diode sensors from the R&S NRP-Z1x and R&S NRP-Z2x series are used, this method must be employed if the bursts are so short that their power cannot be measured in the *Burst Av* or *Timeslot* modes.

Smoothing of modulated Signals – ⬭

To reduce result fluctuations caused by modulation, this parameter should always be activated if the size of the sampling window cannot be exactly adjusted to the modulation period or if this is not required. If the size of the sampling window is 5 to 9 times greater than a modulation period, in general, the reduction in display fluctuation will be sufficient. With smoothing off, 300 to 3000 periods are required to obtain the same effect (☞ Sampling Window).

Background information

Sampling window

As the sensor amplifiers use chopping, a measurement comprises at least two sampling windows and a sensor-specific deadtime of a few 100 µs. Samples at equal time intervals over the duration of a sampling window are taken and a partial measurement result is formed from these samples. The partial measurement results of two adjacent sampling windows are combined and the average is either output as the final result or is subjected to further averaging as one of a number of intermediate results (☞ Filter / averaging, page 4.15).

In the remote control mode, the sampling window determines the minimum measurement time that can be achieved (2 × sampling window + deadtime). However, there is no point in selecting sampling window times very much smaller than 1 ms if, to reduce display noise, the averaging filter has to be used. Due to the unavoidable deadtime of the order of a few 100 µs per sampling window, the measurement time does not drop in proportion to the reduction in sampling window time. This may even mean that, to obtain a well-defined noise component in the result, a greater measurement time overall is required, if a sampling window that is too small is selected.

Smoothing modulated signals

With smoothing turned off, the samples within a sampling window are given equal weighting and averaged, which turns the instrument into an integrating device. As described above, optimal reduction of fluctuations in the measurement result due to modulation can be obtained, if the size of the sampling window is an exact integer multiple of the modulation period. If this is not the case, modulation can have a considerable effect even if the sampling window is many times greater than the modulation period. This situation can be improved considerably if the samples are weighted (raised von-Hann window) before averaging. This is like video filtering and is exactly what happens when smoothing is activated.

Measuring the average burst power

Mode : Burst Av

The Burst Average mode is the simplest method of measuring the average burst power. It is available with sensors from the R&S NRP-Z1x and R&S NRP-Z2x series.

When this mode is selected, the sensor itself detects the start and end of the burst; no external trigger signal is required. The parameter Dropout Tolerance and the trigger parameters Holdoff and Hysteresis are ways of providing stable triggering. Using the parameters Exclude from Start and Exclude from End, the starts and ends of bursts can be excluded from the measurement. This means that signal overshoots can be omitted from measurements, for example.

See the operating manual for the sensor for further information on the Burst mode.

Mode dialog box:

Cont Av, **Burst...** – ↔

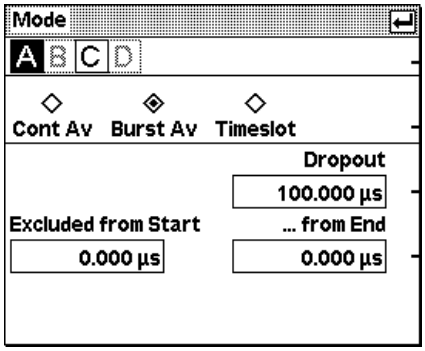


Fig. 4-9 Mode dialog box, Burst mode

Dropout Tolerance – Prevents brief power drops due to modulation from being misinterpreted as the end of a burst.

Caution

The Dropout Tolerance must be less than the no-power interval between the end and start of a burst.

Excluded from End – This time interval before the end of the burst is excluded from the measurement.

... from Start – This time interval after the start of the burst is excluded from the measurement.

Background information

Dropout tolerance

The **Dropout** parameter facilitates the clear identification of the burst end of modulated signals (e.g. NADC). Without this parameter, the end of the burst might erroneously be detected within the burst owing to the considerable modulation-specific power drops of such signals. **Dropout** is set to at least the duration of the burst, which means that the end of the burst cannot be recognized before the set dropout time has elapsed after the trigger level has fallen below the trigger threshold. If the trigger threshold is exceeded again during the dropout time, the process restarts from the beginning.

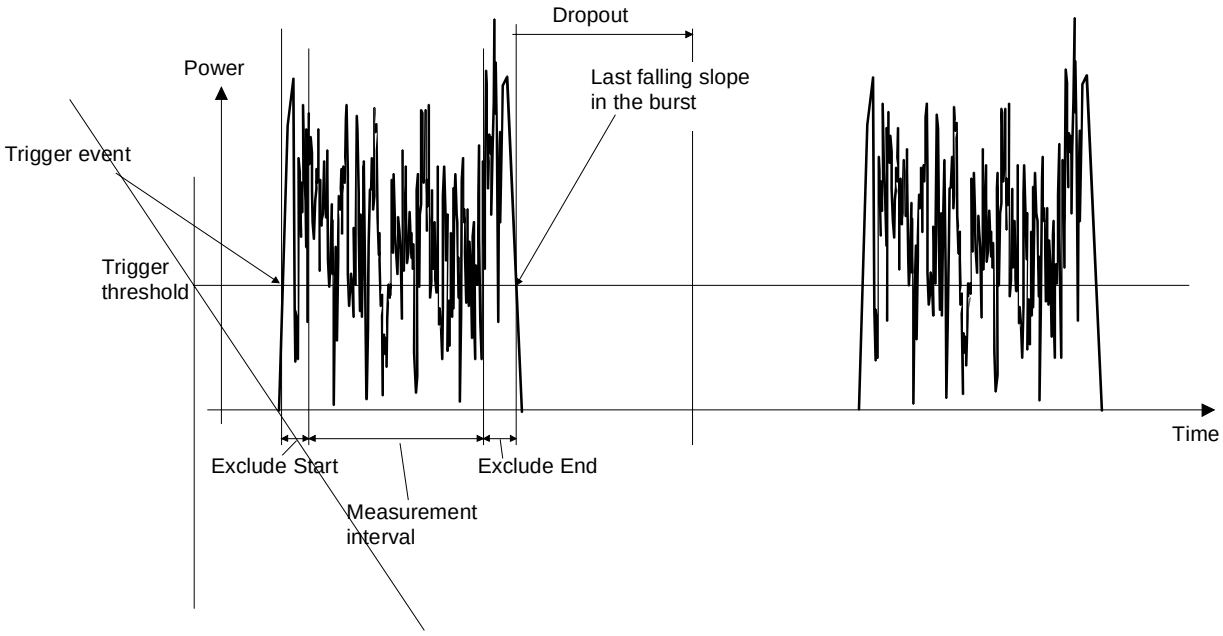
Timing diagram

The timing diagram below shows the relation between the following parameters:

- Trigger threshold and trigger event
- Trigger event, exclude intervals and measurement interval

During the burst the signal frequently falls below the trigger threshold without the end of a burst being detected. The reason for this is that the signal then also quickly exceeds the trigger threshold, which means that the dropout time has not yet elapsed.

During the dropout time indicated below, the signal no longer exceeds the trigger threshold so that the last falling slope in the burst is detected as the end of the burst.



Measuring average power in a specific timeslot

Mode : Timeslot

The Timeslot mode is a particularly flexible way of measuring average power in defined timeslots. This mode is available only with sensors from the R&S NRP-Z1x and R&S NRP-Z2x series.

When this mode is selected, the average power can be measured in a timeslot with a user-selected duration and also measured simultaneously in up to 26 consecutive timeslots with the same duration. It is also possible to exclude an interval at the start and at the end of every timeslot from the measurement with the parameters Exclude Start and Exclude End.

The measurement can be started with an external trigger signal and also by an internal trigger (☞Trigger settings, page 4.20).

Mode dialog box:

Burst Av, Timeslot... –⬭ ↔

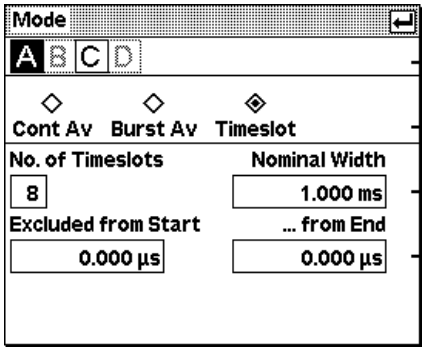


Fig. 4-10 Mode dialog box, Timeslot mode

No of Timeslots –⬭

Number of timeslots on which a simultaneous measurement is to be made.

Nominal Width –⬭

Timeslot length.

When measurements are made on TDMA signals (GSM/EDGE, PDC, NADC, PMS etc), the nominal timeslot length must be entered here, i.e. the frame length divided by the number of timeslots.

GSM example:

Frame length:	4.615	ms
No. timeslots:	8	
⇒ Nominal width	4.615 / 8	ms
	= 576.875	µs

Excluded from End –⬭

These intervals at the start/end of the timeslot whose length is defined with **Nominal Width** are excluded from the measurement.

... from Start –⬭

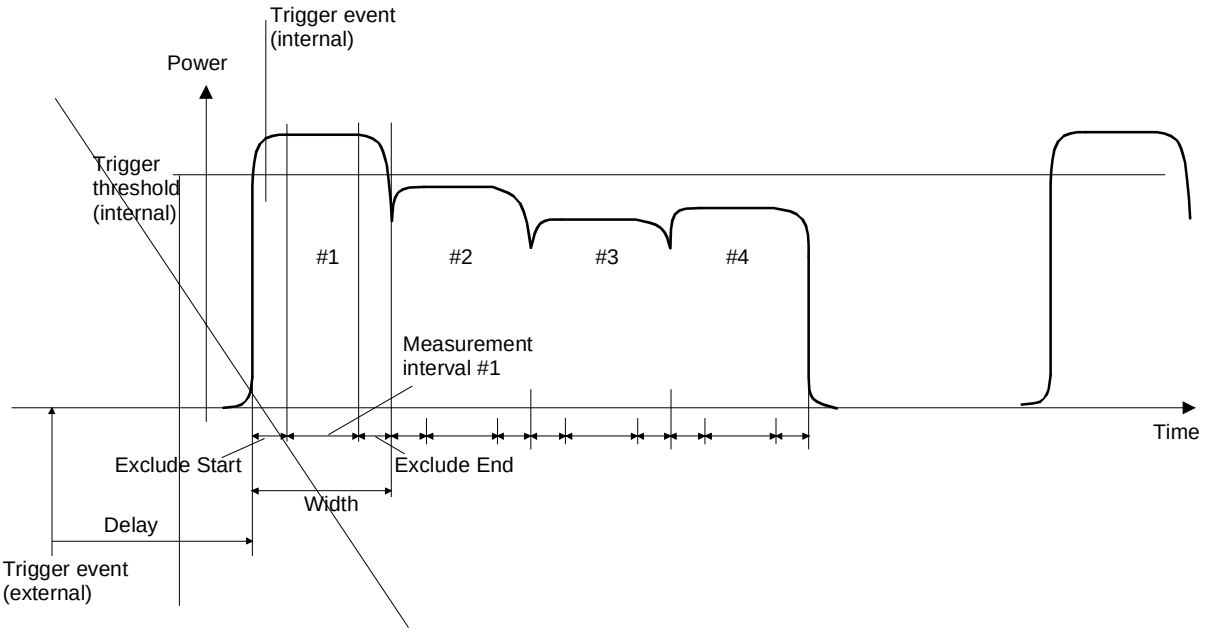
This means that the measurement can be restricted to certain sections of a timeslot and the transients at the start and end of the timeslot can be omitted.

Background information

Timing diagram

The timing diagram below shows the relation between the following parameters:

- Trigger event, trigger delay and start of the first timeslot
- Width, exclude intervals and measurement interval of the timeslots



Offset correction

Sensor→Offset…

The Offset dialog box is for activating and entering correction factors to effect an increase or decrease in the measurement result which is not level-dependent. This means that the effects of any attenuators, directional couplers or amplifiers that are connected ahead of the sensor can be allowed for.

Global is used to set a fixed correction factor. Frequency-dependent corrections can be made with **Table**. Both types of correction can be made simultaneously.

S Parameter Device is for correcting the effects of a twoport connected ahead of the sensor in terms of its S-parameters. The S-parameters of the twoport must be stored in the sensor (see *Program module Update S_Parameters* in the sensor operating manual).

Sensor menu:

Offset… –

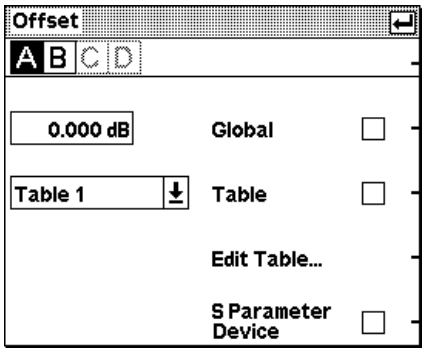


Fig. 4-11 Offset dialog box

A | B | C | D – ↔

Tabs for selecting the sensor.

… **Global** –

Field for entering the global offset.

Positive values correspond to external losses, negative values to external gains.

Global –

Activates the global offset correction.

Table –

The left-hand Table softkey opens a drop-down list with correction tables. There are 10 tables, each of which can contain up to 80 frequency/offset pairs. The default names of the Tables are Table 1 to Table 10; however, the names can be changed using the table editor.

Table –

Activates the frequency-dependent offset correction specified in the Table you have selected.

Edit Table… –

Opens a dialog box for editing the offset correction table you have selected.

S Parameter Device –

Activates the S-parameter set stored in the sensor for a twoport that has been connected ahead of the sensor.

Table editor for offset tables

Offset : Edit Table…

The table editor displays the name of the table being edited in its title bar. Below the title bar, there is a two-column list containing frequency and offset pairs.

There are two table-editor modes:

- **Selection mode:** In this mode, using the up/down cursor keys, you can select the number field you want to **Edit**, **Insert** or **Delete**.

Note: The whole of a long list cannot be displayed in the window. The entries are, therefore, viewed through a "window" which automatically moves if the cursor keys take the cursor outside the section that can be seen. The position of the currently active field is shown by the scroll bar.

- **Edit mode:** When you press the **Edit** rocker switch the value in the selected field can be edited. In this mode, the cursor keys cannot be used for selection, but can be used "normally" to edit values in the entry field.

Offset dialog box:

Edit Table –

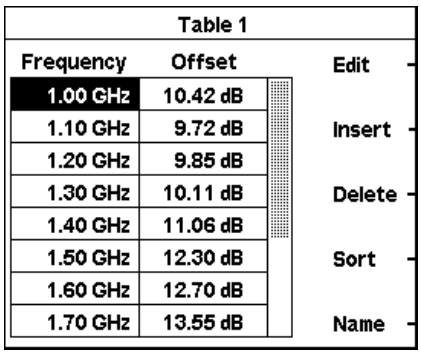


Fig. 4-12 Offset dialog box, Table editor

(↑), (→), (↓), (←) In the selection mode, the cursor keys are used to select the field you want to edit.

Edit – For selecting the edit mode for the marked field.

The entry can be confirmed with the (↵MENU) key or aborted with the (ESC) key. Afterwards, the table editor is again in the selection mode.

Insert – Inserts a new line containing the values of the selected line. The values from the line in the selected field are also copied into the new fields.

The maximum table length is 80 lines.

Delete – Deletes the marked line.

Sort – Sorts the lines in the table so that the frequencies in the lines are in ascending order.

Name – For renaming the selected table to make it easier to identify. The character editor is described in Chapter 3, in the section *Dialog boxes and their controls*.

Filter / averaging

Sensor→Filter…

The averaging filter reduces fluctuations in results caused, for example, by the intrinsic noise of the measuring device, modulation of the test signal or by the leakage of adjacent carriers, to any magnitude you want. A more stable display has to be traded off against longer measurements.

Note *In manual mode, "longer measurements" does not mean that it takes longer to display a new result, but rather that it takes longer for the result to settle when the power changes.*

The measurement result is obtained from a two-stage averaging process. First, a measured value is obtained for the time window specified in the Mode dialog box – either by weighted summation of samples or by integration.

Mode	Sensor	Time window
ContAv	R&S NRP-Z1x or R&S NRP-Z2x	☞ Sampling Window (page 4.6)
Timeslot	R&S NRP-Z1x or R&S NRP-Z2x	☞ Nominal Width (page 4.11)
Burst	R&S NRP-Z1x or R&S NRP-Z2x	Determined by the sensor according to the signal

Measurements are continuously repeated in the selected time window. Repetition occurs in the *ContAv* mode and then immediately after in the *BurstAv* and *Timeslot* modes after the next trigger event. The measurement result is obtained by averaging the measured values for the last 2N time windows. The number N is the filter length (**Length**), the factor of 2 arises because the output signals from the microwave detector to suppress low-frequency noise are chopped at the same rate as the time windows, which means that an independent measured value can only be obtained from two consecutive values.

The filter length can be selected automatically or can be manually set to a fixed value. As a preliminary, you should always check if the autofilter mode is giving satisfactory results because you will always have to adjust an optimal, manual filter-length setting if the power is not constant.

There are two autofilter operating modes.

The **Normal** mode finds a balance between measurement time and display noise. Display noise can be adjusted using the **Resolution** parameter in the **Windows** menu (☞ Resolution, page 4.25). A higher resolution means greater filter lengths and so longer measurements.

In the **Fixed Noise** mode, the filter length is selected so that the sensor's intrinsic noise (2 standard deviations) does not exceed the specified **Noise Content**. To avoid very long settling times when the power is low, the filter length can be limited with the **Max Settling Time** parameter. If the display noise then exceeds this preset value, the symbol **S/N** is displayed.

Sensor menu:

Filter…

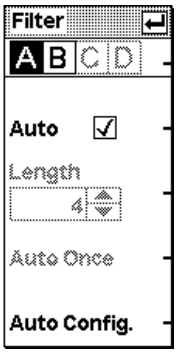


Fig. 4-13 Filter dialog box

A | B | C | D Tabs for selecting the sensor.

Auto Toggles between automatic and manual filter setting.

Length For setting the filter length manually. The function can be called only when autofilter is off. Changes are made immediately when a key is pressed.

Auto Once Determines a "one-off" optimal filter length for the instantaneous measured value and enters this value in the **Length** field. This function can be called only when autofilter is off.

Auto Config… Opens a dialog box for configuring the autofilter mode.

Filter dialog box:

Auto Config…

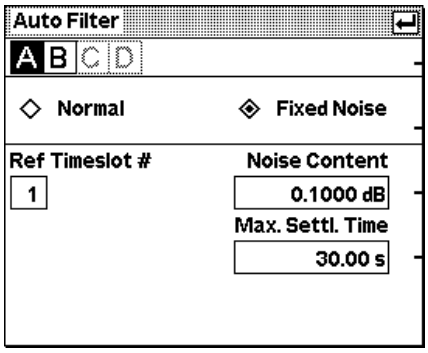


Fig. 4-14 Auto Filter dialog box

A | B | C | D Tabs for selecting the sensor.

Normal Selects the autofilter **Normal** mode.

Fixed Noise Select the autofilter **Fixed Noise** mode.

Noise Content Selects the proportion of intrinsic noise in the measured result. Specifically, **Noise Content** gives the permitted relative variation of the result which may not be exceeded for 95% of the observation time.

Max Settling Time – Specifies an upper limit for the settling time in the **Fixed Noise** mode.

Limit exceeded ⇨ **S/N**

Ref Timeslot – Specifies the timeslot to which autofilter is applied when measurements are being performed in the **Timeslot** mode. This function is not available in the other measurement modes.

Measurement ranges

Sensor→Range…

R&S NRP sensors do not have measurement ranges in the conventional sense. Instead, the R&S NRP-Z1x and R&S NRP-Z2x multipath diode sensors have several measurement paths with different sensitivities which are always simultaneously active. The **Auto** range function automatically selects the most suitable paths, i.e. those that are neither overdriven or underdriven. The final measurement result for the "crossover" of the two measurement paths is derived from the measured values for both paths. There are only a few cases where it makes sense to intervene in this process, e.g. test signals with a large peak-to-average ratio.

To prevent measurement paths which have been overdriven by signal peaks from being included in the evaluation, the **User defined Crossover** function can be used to reduce levels in the measurement path crossover. The effect of setting the **Level** parameter to –6 dB, for example, is to reduce the crossover by 6 dB. This corresponds to an increase in drive range of the same magnitude, which reduces measurement deviations due to modulation to 25% of the original value.

While large signal characteristics improve as the crossover level drops, the effects of zero deviations and intrinsic noise on the result become more marked. The reason for this is that above the crossover ranges the less sensitive of the two measurement paths is underdriven. This is why there is little point in changing the crossover level by more than 10 dB.

If you want to turn off the **Auto** range function, e.g. to test the drive range of a path, you can define one of the three paths as the measurement range with **Path**.

Thermal sensors (R&S NRP-Z5x) have only one measurement range over the whole dynamic range. No facilities for switching between measurement ranges are, therefore, provided.

Sensor menu:

Range… –

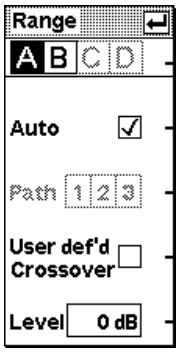


Fig. 4-15 Range dialog box

A | B | C | D – ↔ Tabs for selecting the sensor.

Auto – For turning the **Auto** range function on/off.

Path 1 3 – For selecting a measurement path when the **Auto** range function is off.

User def'd Crossover – Activates a decrease in the crossover range.

Level – dB value by which the crossover level is reduced.

Editing field with direct entry of values (see Chapter 3, *Dialog boxes and their controls*).

Effect of the RF source

Sensor→RF Source…

In this dialog box, you can enter information relating to the reflection coefficients, Γ, of the signal source. The R&S NRP can use this information for two purposes.

If **Source Γ considered for Enhanced Accuracy** is activated, measurement accuracy can be increased by correcting for the effect of source mismatch on the measured value (gamma correction). To do this, the magnitude and phase of Γ must be specified. If Γ

Sensor menu:

Source Match… –

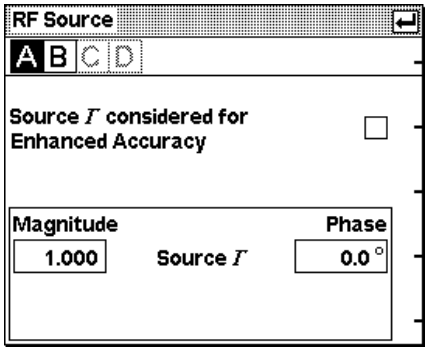


Fig. 4-16 RF Source dialog box

A | B | C | D – ↔ Tabs for selecting the sensor.

Source Γ considered for Enhanced Accuracy – Increases measurement accuracy with gamma correction.

Source Γ Magnitude – Magnitude of the source reflection coefficient Γ.

Source Γ Phase – Phase of the source reflection coefficient Γ.

Trigger settings

Sensor→Trigger…

The trigger system, which is required for the BurstAv, Timeslot and Scope measurement modes, is configured in the **Trigger** dialog box and the **Trigger (Adv)** dialog box.

Sensor menu:

Trigger…

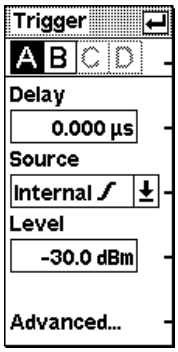


Fig. 4-17 Trigger dialog box

A | B | C | D ↔

Tabs for selecting the sensor.

Delay

Delay between the trigger and the start of the first timeslot (enter a negative value when the order is reversed).

Editing field with direct entry of values (see Chapter 3, *Dialog boxes and their controls*).

Source

Drop-down list for the trigger source (external or internal) and trigger slope (positive or negative).

Level

When this level is exceeded, a measurement is triggered (or when the signal drops below this level in the case of a falling slope).

Editing field with direct entry of values (see Chapter 3, *Dialog boxes and their controls*).

Advanced…

Calls a dialog box for entering advanced trigger settings.

Trigger dialog box:

Advanced…

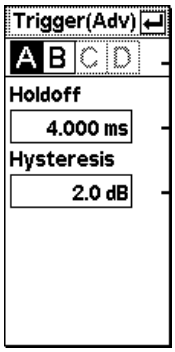


Fig. 4-18 Trigger Advanced dialog box

A | B | C | D ↔

Tabs for selecting the sensor.

Holdoff –⬭ Allows the Holdoff time to be entered. During the Holdoff time, which starts with the trigger event, other trigger events are suppressed.

Editing field with direct entry of values (see Chapter 3, *Dialog boxes and their controls*).

Hysteresis –⬭ Sets trigger-level hysteresis. The PEP must be less (greater) than trigger level – hysteresis (trigger level + hysteresis) before triggering can occur again (brackets refer to triggering on the falling slope).

Editing field with direct entry of values (see Chapter 3, *Dialog boxes and their controls*).

Displaying measurement results

Windows - menu

Window labelling

The R&S NRP has a total of four windows for displaying results. They are numbered 1 to 4 and so have a unique label. The window's number is displayed in the top left of its title bar.

Note: Remote control commands that act on windows contain the number of the window in question in the command, e.g. `DISPlay:WINDow2:SELect.`

Windows can also be assigned a name. The **Window Name** function in the **File** menu is used to assign names to windows. The name is also displayed in the window's title bar and makes it easier to identify results. A name like *Amplifier output* is more informative than *Channel A* or *Window 2*. Window names are stored in the setups. Using "evocative" window names makes it much easier to remember which measurement is performed by any setup window at a later date.

Arranging windows

Displayed windows are shown in numerical order from the top to the bottom of the screen. The R&S NRP automatically selects the window size according to which combination of windows is displayed.

The windows menu

The windows menu is context-sensitive and displays only those menu items that are relevant to the current measurement scenario.

Selecting a window

Windows→Window

You can select one of the windows numbered 1 to 4 whenever you want. All the functions offered in the **Windows** and **Measurement** menus act on the selected window.

Fig. 4-19 Windows menu, Window softkey

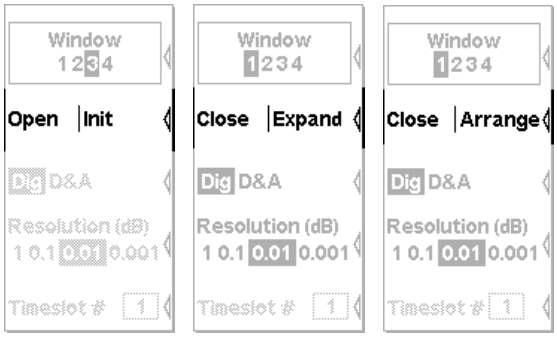
Windows menu:

Window
2 3 4

Selects the window whose number is highlighted in the menu. If the window is already open, it is also identified by the window title bar being in inverse video and by the "shadow" that appears along the right and bottom edges of the window.

Using windows

The labelling of the second rocker switch in the Windows menu is context-sensitive and changes according to the status of the active window.



☞ Open and ☞ Init open the window with the number that has been selected.

☞ Close closes the selected window.

☞ Expand expands all windows to fill the display.

☞ Arrange arranges all the windows on the screen.

Fig. 4-20 Windows menu, softkeys for controlling the windows

Opening windows

Windows→Open

Windows menu:

Open | Init –

Opens a window with the previous settings. This means that a measurement which has been removed from the display can be restored.

Creating windows

Windows→New

Windows menu:

Open | **Init** –

Configures a completely new measurement. All window parameters are reset to the preset (i.e. default) values.

Closing windows

Windows→Close

Windows menu:

Close | Expand –

Closes an opened window. The sizes of any remaining windows are adjusted accordingly.

Expanding windows

Windows→Expand

Windows menu:

Close | **Expand** –

All opened windows are expanded to the full display height. The selected window is the only window that can be seen as all the other windows are “masked” by the selected window. However, the “masked” windows are still open and can be selected in sequence with **Window 1 2 3 4** or by means of the up/down cursor keys.

Expanded windows display all relevant parameters. For a graphical representation of the various window types and a description of symbols see Chapter 3, *Window sizes and types*, *Special symbols*.

Arranging windows

Windows→Arrange

Windows menu:

Close **| Arrange** –

Expanded windows are reduced to their normal size and returned to their original state with **Arrange**.

Selecting the result display mode

Windows→Type

In the windows, a variety of result display modes can be selected.

Fig. 4-21 Window menu, softkeys for controlling the display mode

The digital display (**Dig**) displays measured values as a number with additional information next to the reading.

The hybrid digital/analog display (**D/A**) displays the measured value on an analog scale and also digitally.

Windows menu:

Dig D/A – ↔

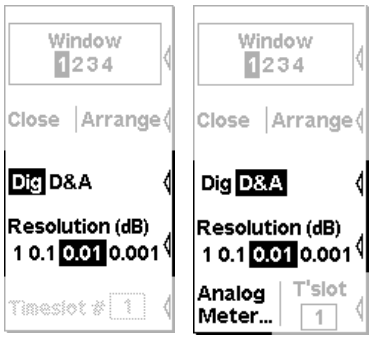
The **Dig D/A** softkey is used for switching between the various window display modes.

Dig D/A – ↔

Hybrid digital/analog display.

Configuring the result display

Each of the display modes has special configuration parameters.



In the digital display, the resolution is adjustable (☞ Resolution, page 4.25).

In the hybrid digital/analog mode, you can adjust the resolution of the digital display (☞ Resolution, page 4.25) and specify the scaling for the analog scale (☞ Scale, page 4.26).

Fig. 4-22 Windows menu, display-specific softkeys

Setting the resolution (Resolution)

Windows→Resolution

The resolution of the digital measurement result can be set in 4 stages, designated as 1 dB, 0.1 dB, 0.01 dB and 0.001 dB. If dB, dBm or dBµV are selected as the unit, the number of digits after the point that is displayed is set directly. In the linear mode (W, Δ%, 1), the number of digits after the point depends on the resolution, a digit being added or removed for each resolution stage that is added or removed.

The selected resolution also influences the action of the autofilter in the ☞ The **Normal** mode (see page 4.15). The greater the selected resolution, the longer the averaging filter to reflect the number of digits.

Windows menu:

Resolution (dB) – ⬭
0.1 0.01 0.001 ↔

Sets the result resolution you want.

Setting the analog scale

Windows→Scale

The scaling for the analog scale in the hybrid digital/analog mode (**D/A**) can be set with the **Scale** softkey.

Windows menu:

Analog Meter… –

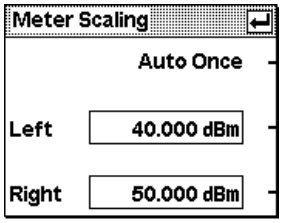


Fig. 4-23 Meter Scaling dialog box

Auto Once – Automatically selects the scaling so that the instantaneous measured value is in the middle of the scale.

Left – Specifies the value at the left-hand end of scale.

Right – Specifies the value at the right-hand end of scale.

Scrolling between timeslots

Windows→Time Slot

If the timeslot mode has been selected for a sensor, you can use the **Time Slot** softkey in the Windows menu to select the timeslot whose measured values you want to display.

Fig. 4-24 Windows menu, softkey for scrolling between timeslots

Windows menu:

Time Slot –

1 ↔

Specifies which of the timeslots on which a simultaneous measurement is being performed are displayed in the active window.

If you want to display further timeslots simultaneously, a separate window must be opened and configured for each additional timeslot.

Configuring measurements

Measurement - menu

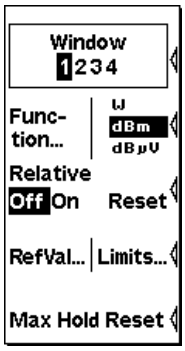
Measurement windows

For every window opened via the **Windows** menu, you can configure a measurement in the **Measurement** menu. The measurement channels (A, B, C and D), how the measured values are processed (ratio, difference), the unit for the result, additional information (max, min), etc are also defined. This procedure does not change the sensor operating modes that have been set in the Mode menu. All key parameters are displayed along with the result in the appropriate window.

In the manual mode, four measurements can be configured, corresponding to the maximum number of windows (1, 2, 3 and 4); in the remote control mode, additional measurements 5 to 8 can be configured (not displayed on screen).

The Measurement menu

The Measurement menu contains the functions required to configure measurements.



- ☞ Selecting a window, page 4.27.
- ☞ Selecting a measurement function and the unit, page 4.28.
- ☞ Relative measurements, page 4.32.
- ☞ Setting the reference value manually, page 4.32.
- ☞ Limit monitoring, page 4.33.
- ☞ Resetting the extreme value display, page 4.32.

Fig. 4-25 Measurement menu

Selecting a window

Window→Window

You can select one of the windows (1 to 4) as and when you want. All **Windows** and **Measurement** menu functions act on the selected window.

Measurement menu:

Window
2 3 4

Selects the window whose number is displayed in the menu. If the window is open, this is also indicated by the window's title bar being in inverse video and by the "shadow" along the window's right and bottom edges.

Selecting a measurement function

The R&S NRP can combine measured values from several channels (sensors) using a mathematical function and display the result. The necessary settings are made in the **Function...** dialog box.

The first step is to select the measurement function, i.e. the mode of combination for multi-channel measurements. Possible functions are the power ratio of two channels, a matching measurement function derived from this or the power in a single measurement channel. All or any of the connected sensors can be selected. A primary channel, and possibly a secondary channel, can be selected for each measurement window.

The simplest case is a measurement with just one sensor. To configure this measurement, first of all select **Primary (X)** or **Secondary (X)** (**X** = **A**, **B**, **C** or **D)** in the **Function** list and then the channel (sensor) you want in the **Primary Channel** or **Secondary Channel** list. Select the function **Ratio (X/Y)** to measure the power ratio and then the measurement channel assignment. For all dual-channel measurements, the first argument "X" of the measurement function is the primary measurement channel. For the sake of clarity, the primary measurement channel is referred to as the **Incident Channel** for matching measurement functions (SWR, Rcoeff and Rloss) and indicates the forward wave, i.e. the wave that is incident at the DUT.

Measurement menu

Function...

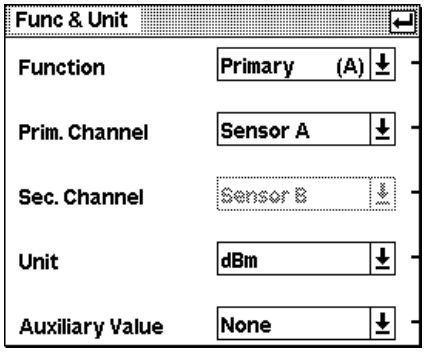


Fig. 4-26 Func & Unit dialog box

Functions and their use

Func & Unit : Function

Func & Unit dialog box

Function – ↔

The **Function** drop-down list itemizes all the measurement functions provided by the R&S NRP. These are:

Function

Primary	(A)	Power in the primary channel, e.g. A.
Secondary	(B)	Power in the secondary channel, e.g. B.
Ratio	(A/B)	Ratio of the power in the primary channel to the power in the secondary channel.
SWR	(A,B)	Standing wave ratio
Rcoeff	(A,B)	Reflection coefficient
Rloss	(A,B)	Return loss
Diff	(A-B)	Power difference between the primary and secondary channel.

The functions for the matching measurement are so defined that the forward power must be measured in the primary channel and the reverse power in the secondary channel.

Prim. Channel – ↔

Selects the primary channel which is to be used to calculate the displayed value.

Sec. Channel – ↔

Selects the secondary channel which is to be used for the calculation.

Setting units

Func & Unit : Unit

Unit –

The **Unit** drop-down list is used to set the result unit. Only those units which are compatible with the selected measurement function are included as menu items:

Function	**Unit**
Single, Diff	W, dBm, dBµV
Ratio	%, dB, 1
SWR, RCoeff	1
RLoss	dB

Measurement menu:

Func tion… | ***W*** ***dBm*** ***dBµV*** –

In the Measurement menu, you can directly scroll through the units compatible with the selected measurement function using the right-hand side of the function rocker-switch.

The following Tables list the mathematical functions used for each measurement function, the set unit and the settings for ☞ Relative measurements (page 4.32):

Rel off

	W	**dBm**	**dBµV**
Single	P	$10\log\left(\frac{P}{1\text{mW}}\right)$	$20\log\left(\frac{\sqrt{P\cdot Z}}{1\,\mu\text{V}}\right)$

	dB	**Δ%**	**1**
Ratio	$10\log\left(\frac{P_A}{P_B}\right)$	$100\left(\frac{P_A}{P_B}-1\right)$	$\frac{P_A}{P_B}$
SWR (A,B)	–	–	$\frac{1+\sqrt{\frac{P_B}{P_A}}}{1-\sqrt{\frac{P_B}{P_A}}}$
Rcoeff (A,B)	–	–	$\sqrt{\frac{P_B}{P_A}}$
Rloss (A,B)	$10\log\left(\frac{P_A}{P_B}\right)$	–	–

Rel on

	1	**dB**	**Δ%**
Single	$\frac{P}{P_R}$	$10\log\left(\frac{P}{P_R}\right)$	$100\left(\frac{P}{P_R}-1\right)$
Ratio	$\frac{\left(\frac{P_A}{P_B}\right)}{\left(\frac{P_X}{P_Y}\right)_R}$	$10\log\frac{\left(\frac{P_A}{P_B}\right)}{\left(\frac{P_X}{P_Y}\right)_R}$	$100\left(\frac{\left(\frac{P_A}{P_B}\right)}{\left(\frac{P_X}{P_Y}\right)_R}-1\right)$

P	Power
P_A	Power in channel A (forward power)
P_B	Power in channel B (reverse power)
P_R	Reference (power)
$\left(\frac{P_x}{P_Y}\right)_R$	Reference (power ratio)

Setting the auxiliary value

Func & Unit : Auxiliary Value

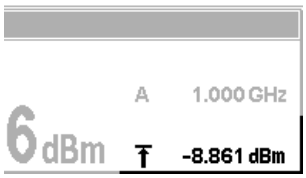


Fig. 4-27 Measurement window, Auxiliary Value

In the Digital display mode, the result and another value that characterizes the result can be displayed.

Auxiliary Value – ↔

Selecting the auxiliary value:

Max	The greatest value that has been measured since the extreme value function was last reset (☞Relative measurements, page 4.32).
Min	The smallest value that has been measured since the extreme value function was last reset (☞Relative measurements, page 4.32).
Max-Min	The interval that includes all values measured since the extreme value function was last reset (☞Relative measurements, page 4.32).

Resetting the extreme value display

Measurement→Max Hold Reset

For each window, the R&S NRP continuously saves the maximum and minimum value measured since the start of the measurement or since these values were last reset. These values should, therefore, be reset before the measurement is started.

Measurement menu:

Max Hold Reset – Clears the extreme values and restarts recording of extreme values.

Additional functions

Relative measurements

Measurement→Rel

The **Rel** function is a simple way of obtaining the ratio of a measured value to a constant value, e.g. a measured power.

Measurement menu:

Rel – **On Reset** ↔ **Off:** Measurement using the measurement function that has been set.

Rel – **Off Reset** ↔ **On:** Relative display mode.

Rel – **Off On** ↔ If the right-hand side of the rocker switch is pressed when **On** is selected, the current measured value is transferred to the active window's reference memory. The display then returns to **On**.

Setting the reference value manually

Measurement→Ref. Val

In those cases where a relative value is to be displayed for a known reference value, the reference value can be entered or edited in the **Ref. Val...** dialog box.

Measurement menu:

Ref. Val… –

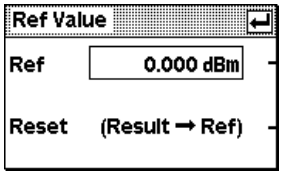


Fig. 4-28 Ref. Value dialog box

Ref. Value – For directly entering a new reference value or for editing an old value.

Result → Ref – The latest measured value is transferred to the reference value memory associated with the active window. This is the same function that is directly activated in the Measurement menu with the **Reset** softkey. You can see the result of this operation immediately in the **Ref. Value** entry field.

Limit monitoring

Measurement→Limits

An upper and a lower limit for each window can be set in the Limits… dialog box. If either limit is violated, a warning is issued. The warning may be one of the following:

- The **LIMIT FAIL** message is displayed on the screen.
- A warning tone is output.
- A signal is output at one of the analog outputs (☞ Setting the analog outputs on page 4.38).

Measurement menu:

Limits… –

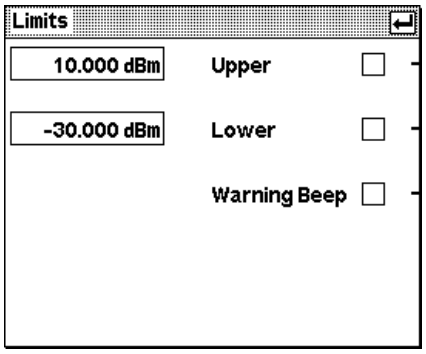


Fig. 4-29 Limits dialog box

Upper – Turns monitoring of the upper limit on/off.

.... **Upper** – Upper limit.

Lower – Turns monitoring of the lower limit on/off.

.... **Lower** – Lower limit

Warning Beep – For activating the acoustic alarm.

Management of settings

File - menu

☞ Saving settings, page 4.34.

☞ System information, page 4.34.

☞ Programmi, page 4.36.

☞ Assigning names to windows, page 4.36.

Fig. 4-30 File menu

Saving settings

The R&S NRP has 19 memories for saving complete device setups (setup memory). The **Setup...** dialog box is used to save new setups and to load previously saved setups. Each memory can be assigned a name for ease of identification.

As well as the 19 read/write setup memories, this dialog box also contains a read-only setup memory containing the default or **Preset** setup.

File menu:

Setup... –

The **Setup...** dialog box can also be opened directly with the PRESET hardkey and is described on page 4.2 .

System information

Information about sensors

File→Info Sensor

The following information about connected power sensors can be obtained with the Info:Sensor dialog box:

- Type and material number of sensor
- Serial number
- Software status
- Date of last calibration
- Frequency and power ranges
- Other technical data

File menu:

Info
Sensor…

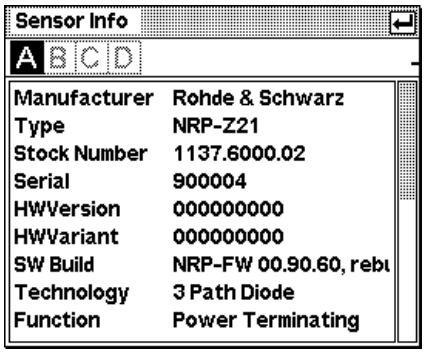


Fig. 4-31 Sensor Info dialog box

A | B | C | D – ↔ Tabs for selecting the sensor.

↵Menu This dialog box can be closed with the ↵Menu key.

↑ ↓ The up/down cursor keys can be used to scroll the window contents if they cannot all be viewed simultaneously.

Information about the R&S NRP

File→Info System

The Info:System dialog box displays the following basic-device characteristics:

- Type and material number of sensor
- Serial number
- Software status of system, BIOS and keyboard controller
- Installed options
- Memory expansions
- Ethernet MAC address (for instruments with option R&S NRP-B4 installed)

File menu:

Info
System…

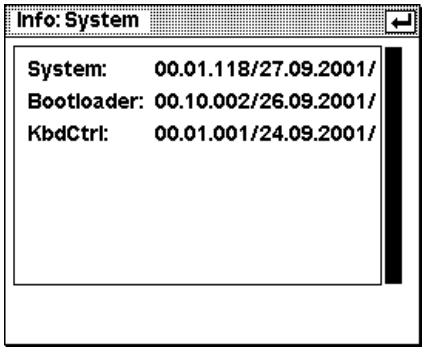


Fig. 4-32 System Info dialog box

↵Menu The dialog box can be closed with the ↵Menu key.

↑ ↓ The up/down cursor keys can be used to scroll the window contents if they cannot all be viewed simultaneously.

Programming aids

File→Errorlist…

If you are developing remote control programs, you can display the contents of the SCPI error queue in the Errorlist dialog box.

The dialog box can be left permanently open, and its contents are continuously updated.

File menu:

Errorlist... –

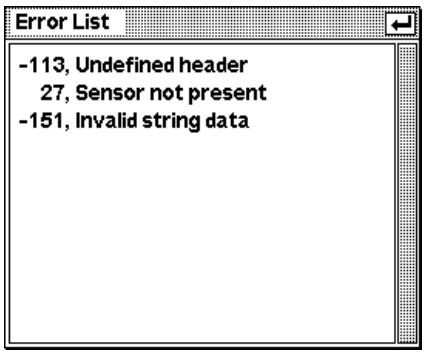


Fig. 4-33 Errorlist dialog box

If the device is already in the remote state, the menu bar is replaced and the Errorlist can be opened with the topmost softkey.

Remote **Error List...** –

Fig. 4-34 Menu bar in the remote control mode

Assigning names to windows

File→Window Name…

The title bar of the display windows contains a name as well as the window number. As standard, the windows are numbered "1", "2", "3" and "4". For the sake of clarity, windows can be assigned names which immediately indicate what the measurement in question is. Name assignment is particularly useful for settings that are to be saved to a setup memory. The **Window Name** dialog box is used to assign names to windows.

File menu:

Window Name... –

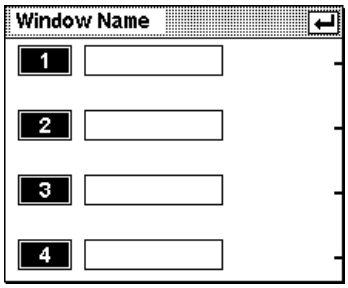


Fig. 4-35 Window Name dialog box

Window 1 – Assigns a name to window 1.

Window 2...4 – Assign names to windows 2 to 4.

System settings

System - menu

- ☞ Configuring the remote control interfaces, page 4.37.
- ☞ Setting the analog outputs, page 4.38.
- ☞ Selftest, page 4.39.
- ☞ Test generator, page 4.41.
- ☞ Operation at low ambient temperatures, page 4.41.

Fig. 4-36 System menu

Configuring the remote control interfaces

System→Remote

Selecting a remote control interface

System menu:

Remote... –

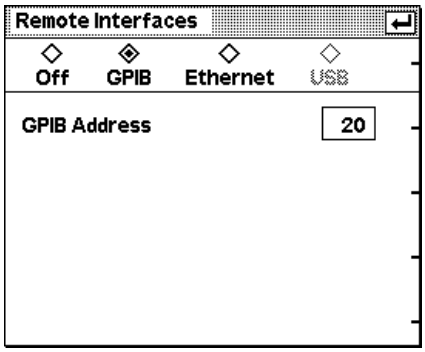


Fig. 4-37 Remote dialog box

GPIB Ethernet – Selects the installed remote control interfaces or turns them off.

Configuring the GPIB

Remote : GPIB

Remote dialog box:

GPIB Ethernet –⬭ ↔ ⇨

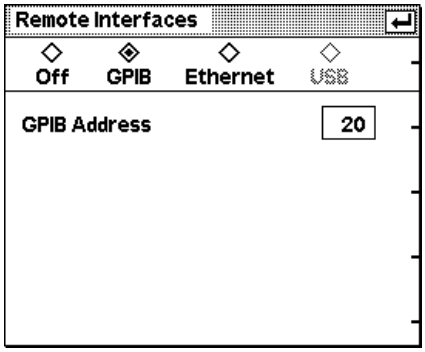


Fig. 4-38 Remote dialog box, GPIB

GPIB Address –⬭ A GPIB address in the range 0 to 30 can be selected.

Setting the analog outputs

System→IO…

There are two multifunction BNC connectors at the rear of the R&S NRP. The function of these connectors is specified in the Analog Out dialog box.

System menu:

IO… –⬭ ⇨

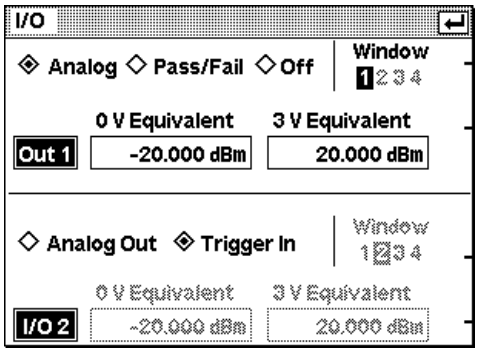


Fig. 4-39 Analog Out dialog box

Analog … LimitFail –⬭ Selects the function of port Out 1 .

When **Analog** is selected, Out 1 outputs a voltage which is proportional to the instantaneous value displayed in the window selected under **Source**.

If **Limit Fail** is selected, Out 1 outputs a logic signal which is used to indicate limit violations in the window selected under **Source**.

Source –⬭ Specifies which window the output at Out 1 and I/O 2 refers to.
2 3 4

Min Value –⬭ Display value which corresponds to an output voltage of 0 V.

Max Value –⬭ Display value which corresponds to an output voltage of 3.3 V.

Pass – Voltage within the limits that have been set. The valid range is 0 V to 3.3 V.

Fail – Voltage when there is a limit violation. The valid range is 0 V to 3.3 V.

Analog Trigger – Selects the function of port I/O 2.

If **Analog** is selected, I/O 2 outputs a voltage which is proportional to the instantaneous value displayed in the window selected under **Source**.

If **Trigger** is selected, I/O 2 acts as a trigger input.

Selftest

System→Test…

While booting up, the R&S NRP performs a system test. Hardware faults are reported at this stage. The system test is described in Chapter 1, *Welcome screen and function test*.

The Selftest dialog box in the System menu is used to check the keyboard and the display and to start a selftest function in the sensors.

System menu:

Test… –

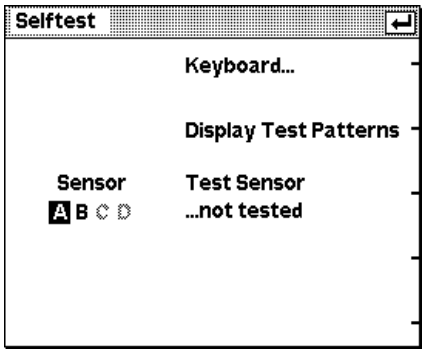


Fig. 4-40 Selftest dialog box

Display Test Patterns – Displays a sequence of different test patterns for checking the display. The procedure can be aborted by pressing any key.

Test Sensor – The right-hand softkey starts a hardware test function in the sensor selected with the left-hand softkey.

Keyboard… – Opens the dialog box for testing the keyboard.

Keyboard test

Selftest : Keyboard…

In the keyboard selftest dialog box, the keys can be pressed in any order. Each time a key is pressed, there is acoustic feedback and the detected key is marked. If a key is pressed more than once a warning is output. This means that specific keys or the whole keyboard can be tested.

This dialog box can be quit only if the ↵ symbol appears on the right of the title bar. This symbol appears either after all keys have been pressed or when no key has been pressed for 15 seconds.

Selftest dialog box:

Keyboard…

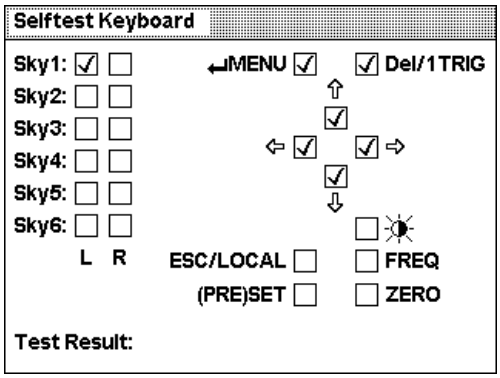


Fig. 4-41 Selftest Keyboard dialog box

The first stage in testing the whole keyboard is to press all the keys in any order without checking each response in the display. If each key has been activated once and only once, an OK message is output and the test is over. Keys that are not activated during the test do not output a tone and afterwards do not exhibit any marking. If a keystroke, e.g. due to a short, activates several keys, a warning message is output during the test. You should then repeat the test, observing the response on the display intensively.

Test generator

System→Power Ref

How to use the test generator (option R&S NRP-B1) for ☞ Zeroing is described on page 4.3.

As it is a high-precision generator with an output power of 1 mW at 50 MHz, it can also be used for other applications.

System menu:

Power Ref Off – Switches the test generator on/off.

Operation at low ambient temperatures

System→Display Update

At very low ambient temperatures, the display becomes sluggish and the rapidly changing decimal places at the end of the reading in particular cannot be reliably determined. To improve readability under these circumstances, you can reduce the display update rate.

System menu:

Display Update Normal – Switches the rate at which the new measured values are displayed between Normal and Slow. The Slow setting has been provided with very low ambient temperatures in mind.

Miscellaneous

System→Miscellaneous

The integral tone generator or beep can be configured in the Misc dialog box, and the date and time of day can be entered.

System menu:

Misc... –

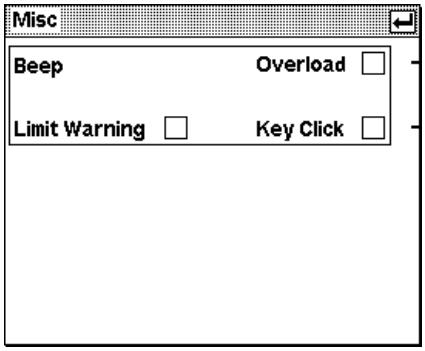


Fig. 4-42 Miscellaneous dialog box

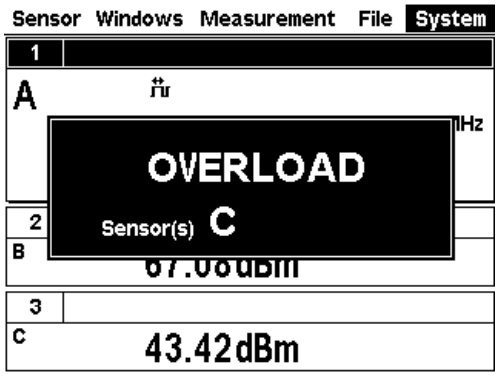
Beep Overload – Activates an acoustic alarm when the sensor is overloaded.

Beep Limit Warning – Activates or deactivates an acoustic alarm when there is a limit violation simultaneously in all measurement windows.

(☞ Limit monitoring, page 4.33).

Beep Key Click – Activates acoustic feedback to indicate when a key is pressed.

Messages and alarms



Overload

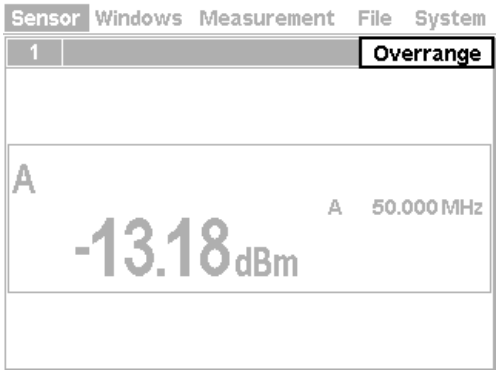
One or more sensors are subjected to overload.

Caution!

Overload can destroy the sensor (depending on amount and duration of overload).

The upper measurement limit is specified in the data sheet for the sensor. The nominal value of the upper measurement limit is also displayed in the Sensor Info dialog box (☞ Information about sensors).

An alarm sounds when the message is displayed. The alarm can be disabled in the **Misc** dialog box (☞ Miscellaneous).

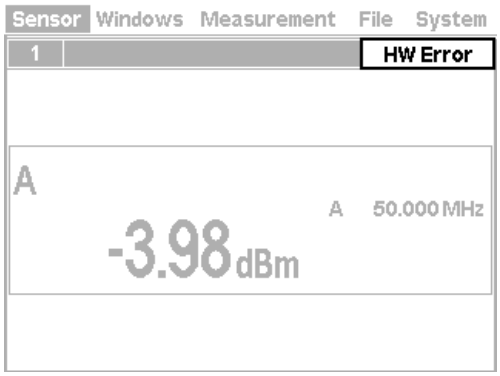


Overrange

This message is displayed only if the **Auto** range function is off. It indicates that the permissible range has been exceeded. (☞ Measurement ranges).

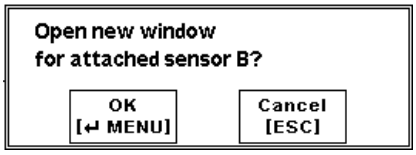
Measurement aborted

Trunc. Meas. is displayed when there is an overflow of the sensor-internal buffer for samples. Overflow occurs if a burst is too long.



Hardware error

A sensor has detected a hardware error.



Automatic window initialization

If an additional sensor is connected to the R&S NRP during operation and if no currently open window displays the values measured in the channel concerned, the R&S NRP automatically offers to open a window and to configure it for measurements with the additional sensor connected.

The previous settings of the newly opened window are lost. To prevent this, we recommend you to cancel with the (ESC) key and to manually configure a window.

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5 Remote Control - Fundamentals

The Power Meter R&S NRP is equipped with an interface that can be connected to a controller for remote control.

- IEC/IEEE-bus interface (standard equipment) in line with the IEC 625.1/IEEE 488.1 standard

The R&S NRP is also equipped with a USB interface for updating the firmware.

Connectors are installed at the rear of the power meter. The two interfaces support the SCPI (Standard Commands for Programmable Instruments) standard, version 1999.0 of May 1999. The SCPI standard is based on the IEEE 488.2 standard and defines a standardized command language for controlling measuring and test instruments with functions beyond the scope of the IEEE 488.2 standard. In addition to the commands, error handling and status management are also described.

The present Chapter explains the differences between remote control and manual control, familiarizes the user with fundamentals of remote control and describes the status reporting system as well as the procedure for connecting a PC for remote control.

Differences between Remote Control and Manual Control

The manual control of the R&S NRP is designed for ergonomic operation. This means, among other things, that setting parameters are assigned default values that cannot be changed and that specific changes of device settings influence other settings. In the remote control mode, all settings can be changed and the user has to make sure that the device is correctly set for the measurement to be performed. We therefore recommend performing a reset (`*RST or →SYSTem:PRESet`, page 6.82) prior to a remote control measurement so that the device is placed in a defined state.

Display

In the REMOTE mode, the display of measured values can be disabled (`SYSTem:SPEed FAST`); the display is cleared except for a status line at the top of the screen. Blanking of menu elements that need not be continually updated increases the data processing speed. The display can be reactivated with the SCPI command `SYSTem:SPEed NORMal`. The backlighting can also be completely switched off with `DISPlay:ILLumination OFF`.

In the remote mode, the menu line at the upper screen edge is blanked and replaced by the indication "Remote Mode". The SCPI error queue can be displayed using the topmost softkey (labelled "Error List..."). If the LLO character is displayed in the upper status line, the keyboard including (ESC/LOCAL) has been disabled via the `LLO` command. In this case, returning to local mode is only possible with the remote control command `GTL` or by a power-on reset.

Measurement Modes

To simplify operation in the manual mode, preset values are used in some cases when the measurement mode (ContAv, BurstAv, Timeslot, Scope) for the trigger system (TRIGger command) and the timing of the measurement (`SENSe[1..4]:TIMing:EXCLude:STARt and :STOP`) are selected (→Table 5-2). This is not the case in the remote control mode. Here the trigger system and the timing can be configured by the user as required.

Calculate Blocks

The R&S NRP manages 8 internal calculate blocks. Each calculate block has two input channels (primary and secondary channel) to which one of up to 4 power sensors can be assigned. The channels can be processed together by means of a selectable function. The result is available at the output of the calculate block. In the manual mode, the measurement results of the first four calculate blocks (→ "CALCulate System", page 6.10) are shown in windows 1 to 4, while 8 calculate blocks are available in the remote control mode.

Connecting a Controller to the Basic Unit

Settings in Basic Unit

Before a link can be established between the controller and the R&S NRP, the R&S NRP must be assigned an IEC/IEEE-bus address. In the manual control mode, this is done in the System→Remote menu.

IEC/IEEE bus configuration:

- Select GPIB as the active interface.
- Set the GPIB address to the desired value. Any value between 0 and 30 is permissible.

Hardware Requirements

IEC/IEEE Bus

In order to control the R&S NRP via the IEC/IEEE bus, a controller with an IEC/IEEE-bus interface and an IEC/IEEE-bus cable are required.

Switchover to Remote Control (REMOTE)

A link has been established between the controller and the R&S NRP and is assumed to have been correctly configured.

After power up, the R&S NRP is always in the manual control mode (LOCAL). The R&S NRP is switched to remote control irrespective of the selected interface as soon as an SCPI command is sent to the R&S NRP. All settings are maintained when the device is switched to the REMOTE mode.

Return to Manual Operation (LOCAL)

In the remote mode, all front-panel controls are disabled. except for the (ESC/LOCAL) key and the topmost toggle softkey used to insert the window with the SCPI error queue. The device remains in this state until it is switched back to manual control either on the front panel (ESC/LOCAL)) or with the remote control command GTL.

Note: *The remote control command* LLO *also allows the* (ESC/LOCAL) *key to be disabled. In this case, return to manual operation is only possible by remote control or by switching the R&S NRP off and on again (Power On Reset).*

Communication on Data Lines

The IEC/IEEE bus is the most common remote interface for measuring devices. It has also been implemented in the R&S NRP. The remote controller and the R&S NRP communicate by means of messages. The messages sent on the data lines (→ section "Interfaces", page 6.104) can be divided into two groups:

- **Interface messages**
- **Device-dependent messages**

Interface Messages

Interface messages are transmitted on the data lines of the IEC/IEEE bus when the ATN control line is active. Interface messages allow the controller and the device to communicate and can only be sent by a controller which serves as the IEC/IEEE-bus controller. Interface commands can be further classified as

- **common commands**
- **addressed commands**

Common commands affect all devices connected to the IEC/IEEE bus without requiring an address, whereas addressed commands only affect devices addressed as a listener. The interface messages relevant for the device are described in the annex → "Interface Messages", page 6.107.

Device-Dependent Messages (Commands and Responses)

Device-dependent messages are transmitted on the data lines of the IEC/IEEE bus when the ATN control line is not active. The ASCII code is used. Device-dependent messages are classified according to the direction in which they are sent:

Commands

are messages sent by the controller to the R&S NRP. They control the device functions and request information. The commands are classified

according to the effect they have on the device:

Setting commands	trigger device settings, e.g. an device reset or a configuration of the trigger system.
Queries	cause device data to be provided in the output queue, where they can be fetched via the IEC/IEEE bus. Queries are available for most of the setting commands. They are obtained by adding a question mark to the setting command.

according to their definition in the IEEE 488.2 and SCPI 1999.0 standard:

Common commands	are precisely defined in the IEEE 488.2 standard in terms of function and notation. They relate to functions such as the management of standardized status registers, resetting and self test.
Device-specific commands	relate to functions that depend on device characteristics such as the frequency setting. Most of these commands are also standardized by the SCPI Consortium (→ "SCPI Standard", page 5.6). The standard allows device-specific extensions of commands.

Parallelism:

Overlapping commands	can be executed while another command is being executed.
Sequential commands	can only be executed when the execution of all other commands is completed.

Note: *In the R&S NRP, only the remote control command* `INIT:IMM` *can overlap with other commands.*

Responses

are messages sent by the device to the controller after a query. This may be measurement results, for instance, or device status information.

Structure and Syntax of Device-Dependent Messages

SCPI Standard

SCPI (Standard Commands for Programmable Instruments) describes a standardized command set for the programming of instruments regardless of the type of instrument or manufacturer. The objective of the SCPI Consortium is to standardize device-specific commands as far as possible. For this purpose, a device model has been developed which defines identical functions within a device or between different devices. Command systems have been created and assigned to these functions so that it is possible to address identical functions with the same commands.
The command systems have an hierarchical structure. Fig. 5-1 shows this tree structure, using details from the SENSe command system which selects the measurement to be performed by the device. Most of the other examples of command syntax and structure are taken from this command system.

SCPI is based on the IEEE 488.2 standard, i.e. it uses the same syntax elements and the common commands defined in IEEE 488.2. The syntax of the responses is subjected to somewhat stricter rules than those specified by the IEEE 488.2 standard (→ section "Responses to Queries", page 5.10).

Command Structure

Commands consist of a header and usually one or several parameters. Header and parameters are separated by a white space (ASCII code 0 to 9, 11 to 32 decimal, e.g. space). The headers may be composed of several keywords. The query is created by appending a question mark directly to the header.

Common Commands

Device-independent commands consist of a header preceded by an asterisk (*) The header may be followed by one or several parameters.

Examples:

***RST** **Reset**, resets the device.

***ESE 253** **Event Status Enable**, sets the bits of the Standard Event Status Enable Register.

***ESR?** **Event Status Query**, queries the contents of the Standard Event Status Register.

Device-Specific Commands

Hierarchy

Device-specific commands have a hierarchical structure (→ Fig. 5-1). The various levels are represented by compound headers. Headers at the highest level (root level) have one keyword only. This keyword describes an entire command system.

Example: `SENSe[1..4]`

This keyword denotes the command system `SENSe<n>`.
For lower-level commands, the full path has to be specified, starting with the highest level in the left-most position. The individual keywords are separated by a colon ":".

Example: `SENSe[1..4]:SWEep:POINts <int_value>`

This command is at the third level of he SENSE system and sets the number of test points for the Scope mode.

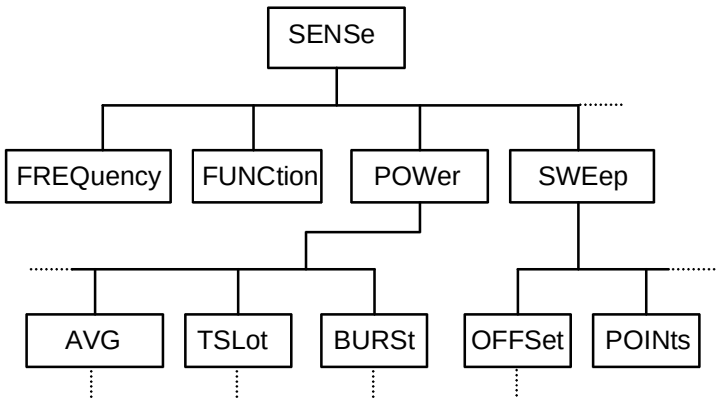

Fig. 5-1: SCPI command tree

Some keywords are used at several levels within a command system. Their effect depends on the command structure, i.e. on their position in the command header.

Example: `SENSe1:SWEep:POINts <int_value>`

This command contains the POINts keyword in the third level.

Example: `SENSe1:SWEep:OFFSet:POINts <int_value>`

This command contains the POINts keyword in the fourth level. It defines the time offset for the display of points in the Scope mode.

Optional keywords:

In some command systems certain keywords can be inserted into or removed from the header. These keywords are shown in the manual in square brackets. For reasons of compatibility with the SCPI standard, the device must be able to recognize the full length of the command. Some of the commands become considerably shorter when the optional keywords are omitted.

Example: `[SENSe1]:POWer:TSLot[:AVG]:COUNt 6`

This command sets the number of timeslots in the Timeslot mode to 6. The following command has the same effect. `:POWer:TSLot:COUNt 6`

Note: An optional keyword cannot be omitted if its effect is specified in more detail by a numeric suffix.

Example: `SENSe2:POWer:TSLot[:AVG]:COUNt 6` in short form:
`SENSe2:POWer:TSLot:COUNt 6`

Long and short form

The keywords have a long and a short form. The keyword may be entered in short or in long form; other abbreviations are not allowed. The short form uses the first four characters of the long form. If the fourth character is a vowel and the long form consists of more than four characters, only the first three characters are used for the short form. The short form is shown by upper-case characters, and the long form is the entire keyword.

Example: `STATus:QUEStionable:ENABle 1` and `STAT:QUES:ENAB 1`

Note: *Upper- and lower-case letters are only used for identifying the long and short form in the manual; the device itself does not differentiate between the two types of characters.*

Parameters

The parameter must be separated from the header by a white space. If a command contains several parameters, they have to be separated by a comma (,). Some of the commands allow the specification of the parameters `MINimum`, `MAXimum` and `DEFault`. For a description of the parameter types see → section Parameters, page 5.11.

Example: `SENSe1:TIMing:EXCLude:STARt? MINimum`
Response: `0`
This query asks for the minimum setting value.

Numeric suffix

If a device has several identical functions or features, e.g. inputs, the desired function can be selected by a suffix to the command. Commands without a suffix are interpreted as having a suffix of 1.

Example: `SENSe2:FUNCtion "POWer:AVG"`
This command sets the measurement mode of sensor 2 to the ContAv mode

Structure of a Program Message

A program message may contain one or several commands. Several commands in a program message are separated by a semicolon (;). If the next command belongs to a different command system, the semicolon is followed by a colon. The colon stands for the root node of the command tree.

Example: `SYSTem:TIME 20,30,00;:SENSe:FUNCtion "POWer:AVG"`

This program message contains two commands. The first command belongs to the SYSTem system and is used to set the time of the system clock. The second command belongs to the SENSe system and must be preceded by a colon. Otherwise confusion might be caused if the SYSTem tree also had a subordinate SENSe node. In this case, it would be possible to omit the introductory keyword `SYSTem`. (see the following explanation:)

If the successive commands belong to the same system and therefore have one or several common levels, the program message may be abbreviated. The second command following the semicolon then starts at the level that is below the common levels. The colon after the semicolon must be omitted in this case.

Example: `SENSe2:TIMing:STARt 10; SENSe2:TIMing:STOP 10`

This program message contains two commands separated by a semicolon. Both commands belong to the SENSe system and its TIMing subsystem, i.e. they have two common levels.

In the abbreviated program message the second command starts at the level below `SENSe:TIMing`. The colon after the semicolon has to be omitted.

The short form of the program message is:

```
SENSe2:TIMing:STARt 10; STOP 10
```

A new program message always starts with the full path however.

Example:
```
SENSe2:TIMing:STARt 10
SENSe2:TIMing:STOP 10
```

Note: *Processing of a program message is aborted if an error occurs. If only sensor 2 is connected to a multichannel device, for example, the program message*

```
SENS1:FREQ 50 GHZ;:SENS2:FREQ 50 GHZ
```

will be aborted after the first command and a second frequency setting will not be performed.

Responses to Queries

Unless otherwise expressly specified, a query is defined for each command. The query is created by appending a question mark to the associated command. Some of the SCPI rules for query responses are stricter than those of the IEEE 488.2 standard:

1. The required value is sent without header.
   Example: `SENSe:AVERage:TCONTrol?`
   Response: `MOV`

2. Maximum and minimum values as well as all other quantities queried by a special text parameter are returned as numeric values.
   Example: `SENSe:POWer:TSLot:COUNt? MAXimum`
   Response: `26`

3. Numeric values are output without a unit. Physical quantities refer to the basic units or to the units set with the UNIT command.
   Example: `SENSe3:FREQuency?`
   Response: `1.000000E06` (for 1 MHz)

4. Boolean values are returned as 0 (for `OFF`) and 1 (for `ON`).
   Example: `SYSTem:BEEPer:STATe?`
   Response: `1`

5. Character data is returned in short form
   (→ also see section "Parameters", page 5.11).
   Example: `UNIT2:POWer?`
   Response: `DBM`

Parameters

Most commands require the specification of a parameter. Parameters must be separated from the header by a white space. Parameters may be specified as numeric values, Boolean parameters, character data, strings or block data. The type of parameter required for the specific command as well as the permissible value range are described together with the commands.

Numeric values Numeric values may be entered in any customary form, i.e. with sign, decimal point and exponent. If the values exceed the resolution of the device, they will be rounded off. Values between -9.9E37 and +9.9E37 can be entered. The exponent is denoted by "E" or "e". The exponent alone must not be used.

Units Physical quantities may be stated with the unit. Permissible prefixes for the unit are `G` (Giga), `MA` (Mega, `MHZ` is also allowed), `K` (kilo), `M` (milli), `U` (micro) and `N` (nano). If no unit is specified, the basic unit will be used.

Some settings allow relative values to be stated in "One" and percent. According to SCPI, these units are represented by the strings `O` or `PCT`.

Unit used in the R&S NRP	SCPI notation
Watt	`W`
dBm	`DBM`
dBµV	`DBUV`
dB	`DB`
1	`O`
%	`PCT`
Hertz	`HZ`
Second	`S`

Example:
`SENSe1:FREQuency 1.5 GHZ` is equivalent to `SENSe1:FREQuency 1.5E9`

Special numeric values The parameters `MINimum`, `MAXimum`, and `DEFault` are interpreted as special numeric values. The numeric value is returned in response to a query.

Example:
Command: `SENSe2:POWer:APERture MAXimum`
Query: `SENSe2:POWer:APERture?`
Response: `1.000000E02`

MIN/MAX `MINimum` and `MAXimum` denote the minimum and maximum value.

DEF `DEFault` denotes a preset value. This value is identical to the basic setting called by the `*RST` command.

NAN Not A Number (`NAN`) stands for 9.91E37. `NAN` is only sent as a device response. This value is not defined. `NAN` is typically returned for dividing by zero, subtracting a value from infinity and representing missing data.

Boolean parameters

Boolean parameters represent two states. The ON state (logical true) is represented by ON or a numeric value other than 0. The OFF state (logical false) is represented by OFF or the numeric value 0. Queries yield 0 or 1.

Example:
Command: `SENSe:POWer:BUFFered ON`
Query: `SENSe:POWer:BUFFered?`
Response: `1`

Character data

Character data follows the syntax rules for keywords, i.e. it also has both a short and a long form. They must be separated from the header by a white space same as any parameter. A query returns the short form of the character data.

Example:
Command: `SENSe2:AVERage:TCONTrol MOVING`
Query: `SENSe2:AVERage:TCONTrol?`
Response: `MOV`

Strings

Strings must always be indicated in single or double quotes.

Example:
`SENSe1:FUNCtion:ON "POWer: AVG"` or
`SENSe1:FUNCtion:ON 'POWer: AVG'`

Block data

The block data format is suitable for the transmission of large data volumes. A command with a block data parameter has the following structure:

Example: `DISPlay:PIXMap?`
Response: `#49600xxxxxxxx.....`

The ASCII character # denotes the beginning of the data block. The next numeral specifies the number of subsequent digits defining the length of the data block. In the example above, the four digits specify a length of 9600 bytes. The data bytes follow next. During transmission of these data bytes, all terminators and other control data are ignored.

Coupled commands

Setting one command influences the value of another command. According to SCPI 1999, this should be avoided but it makes sense when user-friendly high-level measurement commands are to be provided to configure an entire section of the device at once. The high-level commands CONF, FETCh, READ and MEASure are therefore an exception to this rule.

Device Model and Command Processing

The device model shown in Fig. 5-2 was prepared from the point of view of the processing of remote control commands. The individual components operate independently of each other and simultaneously. They communicate with each other by means of messages.

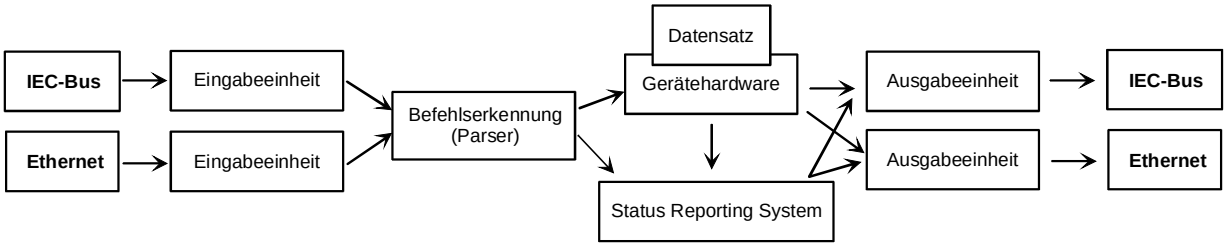

Fig. 5-2: Device model for remote control

Input Unit

The input unit receives the commands in the form of characters from the remote control interface and collects them in the input buffer. The input unit sends a message to the command identification as soon as the input buffer is full or as soon as it receives a delimiter. The received data is processed in the parser (command identification).

Command Identification (Parser)

The parser analyzes the data received from the input unit. Data is processed in the sequence in which it was received. Syntax errors in the command are recognized and passed on to the status reporting system. Following the syntax test, the value range of the data is verified and the setting is adapted. Only after the command has been completely executed will the next command be processed.

Data Set and Device Hardware

The term "device hardware" refers to that part of the device which performs the measurement function.

The data set contains all parameters required for setting the device hardware. Setting commands cause a modification of the data set. Before the data is entered in the data set, it is verified for compatibility both with the other data and with the device hardware. If the setting is not possible, an error message will be sent to the status reporting system and the setting will be ignored. After successful completion of the verification, the setting will immediately be performed.

If the setting influences the result calculation, the MEASuring bit is set in the status operation register until new measured values are available. The MEASuring bit is described in more detail in the Status Reporting System section that follows. This bit may be used for the synchronization of command processing. Queries cause the data-set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the device status and makes it available to the output unit on request. Structure and function of this system are described in the following section.

Output Unit

The data output unit collects the information requested by the controller from the data set management. It processes the information in line with the SCPI rules and makes it available in the output buffer.

Command Sequence and Command Synchronization

All commands are executed in the order in which they are sent. There is no overlapping of command processing. (Exception: the commands `INIT` and `CAL:ZERO:AUTO ONCE`.) The user therefore can determine the sequence of execution.

If a long program message is terminated by `*OPC` or `*OPC?`, the end of command processing is signalled to the controller, provided the controller has been adequately programmed (→ Table 5-1).

Table 5-1: Synchronization with `*OPC, *OPC?` and `*WAI`

Command	Effect	Programming of controller
`*OPC`	Sets the Operation Complete bit in the ESR after all commands sent prior to *OPC have been processed.	Set bit 0 in the ESE of the R&S NRP. Set bit 5 in the SRE of the R&S NRP. Wait for service request (SRQ).
`*OPC?`	Writes 1 in the output buffer after all commands sent prior to *OPC? have been processed.	IEC/IEEE bus: the R&S NRP is addressed as a talker.
`*WAI`	Commands can continued to be sent but they are only executed after completion of all commands sent prior to *WAI.	Send the R&S NRP command.

Annex: Automatic Settings for Manual Selection of a Measurement Mode

When the measurement mode of a sensor is manually selected (Sensor→Mode), automatic settings are made for the trigger system and timing, which cannot be changed by manual control. This considerably simplifies operation. These settings are not changed when the measurement mode is selected by remote control (`SENSe:FUNCtion`) and have to be set to the desired value by appropriate SCPI commands.

The following table lists the respective setting capabilities and the values that are automatically set in manual control.

Table 5-2: Automatic settings for manual selection of a measurement mode

Mode	SCPI command	Value	Remark
ContAv	`TRIGger[1..4]:SOURce`	`IMMediate`	Cannot be modified in manual mode.
	`TRIGger[1..4]:SLOPe`	-	Unchanged, is irrelevant.
	`TRIGger[1..4]:COUNt`	1	Cannot be modified in manual mode.
	`TRIGger[1..4]:DELay`	-	Unchanged, is irrelevant.
	`TRIGger[1..4]:HOLDoff`	1 NS	Cannot be modified in manual mode.
	`TRIGger[1..4]:LEVel`	-	Unchanged, is irrelevant.
	`[SENSe[1..4]]:TIMing:EXCLude:STARt`	-	Unchanged, is irrelevant.
	`[SENSe[1..4]]:TIMing:EXCLude:STOP`	-	Unchanged, is irrelevant.
	`INITiate[1..4]:CONTinuous`	ON	Cannot be modified in manual mode.
BurstAv	`TRIGger[1..4]:SOURce`	-	Unchanged, is irrelevant.
	`TRIGger[1..4]:SLOPe`	-	Unchanged, is irrelevant.
	`TRIGger[1..4]:COUNt`	1	Cannot be modified in manual mode.
	`TRIGger[1..4]:DELay`	-	Unchanged, is irrelevant.
	`TRIGger[1..4]:HOLDoff`	`Depends on sensor`	User-selectable.
	`TRIGger[1..4]:LEVel`	`Depends on sensor`	User-selectable.
	`[SENSe[1..4]]:TIMing:EXCLude:STARt`	`Depends on sensor`	User-selectable.
	`[SENSe[1..4]]:TIMing:EXCLude:STOP`	`Depends on sensor`	User-selectable.
	`INITiate[1..4]:CONTinuous`	ON	Cannot be modified in manual mode.
Timeslot	`TRIGger[1..4]:SOURce`	`EXTernal | INTernal`	User-selectable.
	`TRIGger[1..4]:SLOPe`	`POSitive | NEGative`	User-selectable.
	`TRIGger[1..4]:COUNt`	1	Cannot be modified in manual mode.
	`TRIGger[1..4]:DELay`	`Depends on sensor`	User-selectable.
	`TRIGger[1..4]:HOLDoff`	`Depends on sensor`	User-selectable.
	`TRIGger[1..4]:LEVel`	`Depends on sensor`	User-selectable.
	`[SENSe[1..4]]:TIMing:EXCLude:STARt`	-	Unchanged, is irrelevant.
	`[SENSe[1..4]]:TIMing:EXCLude:STOP`	-	Unchanged, is irrelevant.
	`INITiate[1..4]:CONTinuous`	ON	Cannot be modified in manual mode.

Mode	SCPI command	Value	Remark
Scope	TRIGger[1..4]:SOURce	EXTernal | INTernal	User-selectable.
	TRIGger[1..4]:SLOPe	POSitive | NEGative	User-selectable.
	TRIGger[1..4]:COUNt	1	Cannot be modified in manual mode.
	TRIGger[1..4]:DELay	0 S	Cannot be modified in manual mode.
	TRIGger[1..4]:HOLDoff	Depends on sensor	User-selectable.
	TRIGger[1..4]:LEVel	Depends on sensor	User-selectable.
	[SENSe[1..4]]:TIMing:EXCLude:STARt	0 S	Cannot be modified in manual mode.
	[SENSe[1..4]]:TIMing:EXCLude:STOP	0 S	Cannot be modified in manual mode.
	INITiate[1..4]:CONTinuous	ON	Cannot be modified in manual mode.

Annex: Correspondence between Remote Control and Manual Control

Table 5-3 compares the control elements of the graphical user interface for manual control with the SCPI commands for remote control in order to simplify the transfer of manual control procedures to a remote control program.

Table 5-3: Correspondence between remote control an manual control

Menu item in manual control	SCPI command in short form
Sensor→Mode	SENS[1..4]:FUNCtion
Sensor→Mode→ContAv→Window	SENS[1..4]:POW:APER
Sensor→Mode→ContAv→Sampling Rate	SENS[1..4]:SAMP
Sensor→Mode→ContAv→DutyCycle	SENS[1..4]:CORR:DCYC
Sensor→Mode→ContAv→DutyCycle	SENS[1..4]:CORR:DCYC:STAT
Sensor→Mode→BurstAv→Dropout	SENS[1..4]:BURSt:DTOL
Sensor→Mode→BurstAv→Exclude Start	SENS[1..4]:TIM:EXCL:STAR
Sensor→Mode→BurstAv→Exclude Stop	SENS[1..4]:TIM:EXCL:STOP
Sensor→Mode→Timeslot→No. of Timeslots	SENS[1..4]:POW:TSL:COUN
Sensor→Mode→Timeslot→Nominal Width	SENS[1..4]:POW:TSL:WIDT
Sensor→Mode→Timeslot→Exclude Start	SENS[1..4]:TIM:EXCL:STAR
Sensor→Mode→Timeslot→Exclude Stop	SENS[1..4]:TIM:EXCL:STOP
Sensor→Offset→Global	SENS[1..4]:CORR:OFFS SENS[1..4]:CORR:OFFS:STAT
Sensor→Offset→Table	SENS[1..4]:CORR:FDOT SENS[1..4]:CORR:FDOT:STAT
Sensor→Offset→Edit Table...	See MEMory command system
Sensor→Offset→S Parameter Device	SENS[1..4]:CORR:SPD:STAT
Sensor→Filter→Auto	SENS[1..4]:AVER:COUN:AUTO
Sensor→Filter→Length	SENS[1..4]:AVER:COUN
Sensor→Filter→Auto Once	SENS[1..4]:AVER:COUN:AUTO ONCE
Sensor→Filter→Auto Config...→Normal	SENS[1..4]:AVER:COUN:AUTO:TYPE RES

Menu item in manual control	SCPI command in short form
Sensor→Filter→Auto Config...→Fixed Noise	SENS[1..4]:AVER:COUN:AUTO:TYPE NSR
Sensor→Filter→Auto Config...→Fixed Noise→Ref Timeslot #	SENS[1..4]:AVER:COUN:AUTO:SLOT
Sensor→Filter→Auto Config...→Fixed Noise→Noise Content	SENS[1..4]:AVER:COUN:AUTO:NSR
Sensor→Filter→Auto Config...→Fixed Noise→Max. Settl. Time	SENS[1..4]:AVER:COUN:AUTO:MTIM
Sensor→Range→Auto	SENS[1..4]:RANG:AUTO
Sensor→Range→Path	SENS[1..4]:RANG
Sensor→Range→User def'd Crossover Sensor→Range→Level	SENS[1..4]:RANG:CLEV
Sensor→RF Source	SENS[1..4]:SGAM:CORR:STAT
Sensor→RF Source	SENS[1..4]:SGAM:PHAS
Sensor→RF Source	SENS[1..4]:SGAM
Sensor→Trigger→Delay	TRIG[1..4]:DEL
Sensor→Trigger→Source	TRIG[1..4]:SOUR TRIG[1..4]:SLOP
Sensor→Trigger→Level	TRIG[1..4]:LEV
Sensor→Trigger→Advanced...→Holdoff	TRIG[1..4]:HOLD
Sensor→Trigger→Advanced...→ Hysteresis	TRIG[1..4]:HYST
Windows→Window 1234	DISP[1..4]:SEL
Windows→Open/Close	DISP[1..4][:STAT]
Windows→Expand/Restore	DISP[1..4]:SIZE
Windows→Dig/D&A	DISP[1..4]:FORM
Windows→Resolution	DISP[1..4]:RES SENS[1..4]:AVER:COUN:AUTO:RES
Windows→Timeslot # Windows→T'slot	No correspondence in command set
Windows→Analog Meter...→Auto Once	DISP[1..4]:MET:AUTO ONCE DISP[1..4]:ANAL:AUTO ONCE
Windows→Analog Meter...→Left	DISP[1..4]:MET:LOW DISP[1..4]:ANAL:LOW
Windows→Analog Meter... →Right	DISP[1..4]:MET:UPP DISP[1..4]:ANAL:UPP

Menu item in manual control	SCPI command in short form
Measurement→Window 1234	DISP[1..4]:SEL
Measurement→Function...→Primary Channel Measurement→Function...→Secondary Channel Measurement→Function...→Function	CALC[1..8]:MATH:EXPR
Measurement→Function...→Unit	UNIT:POW and UNIT:POW:RAT
Measurement→Function...→Auxiliary Value = Max = Min = Max - Min	CALC[1..8]:MAX:DATA? CALC[1..8]:MIN:DATA? CALC[1..8]:PTP:DATA?
Measurement→W / dBm / dBµV	UNIT:POW
Measurement→dB / Δ% / 1	UNIT:POW:RAT
Measurement→Rel On / Off Measurement→Rel Reset	CALC[1..8]:REL:STAT and CALC[1..8]:REL:AUTO ONCE
Measurement→Ref. Val...→Ref. Value	CALC[1..8]:REL
Measurement→Limits...→Warning Sound	CALC[1..8]:LIM:BEEP
Measurement→Limits...→Upper Limit On	CALC[1..8]:LIM:UPP:STAT
Measurement→Limits...→Upper Limit	CALC[1..8]:LIM:UPP[:DATA]
Measurement→Limits...→Lower Limit On	CALC[1..8]:LIM:LOW:STAT
Measurement→Limits...→Lower Limit	CALC[1..8]:LIM:LOW[:DATA]
Measurement→Max Hold Reset	CALC[1..8]:EXTR:RES
File→Setup...→Preset	SYST:PRES or *RST
File→Setup...→Save	*SAV
File→Setup...→Recall	*RCL
File→Setup...→Edit Name	MEM:STAT:DEF
File→Sensor Info...	SYSTem:SENS[1..4]:INFO?
File→System Info...	SYSTem:INFO?
File→Errorlist	SYSTem:ERRor?
File→Window Name	DISP:NAME
System→Remote... →GPIB→GPIB Address	SYST:COMM:GPIB:ADDR
System→I/O...	No correspondence in command set

Menu item in manual control	SCPI command in short form
System→Batt...	SYST:BATT:MODE SYST:BATT:DATA?
System→Test... →Sensor ABCD / Init. Test	TEST:SENS[1..4]
System→Power Ref	OUTP:ROSC
System→Display Update	No correspondence in command set.
System→Misc...	No correspondence in command set.
◑	DISP:CONT
(PRESET)	Opens the File→Setup... menu
(FREQ)	SENS[1..4]:FREQ
(ZERO/CAL)	CAL:ZERO:AUTO

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Tables

6 Remote Control - Commands

Notation

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

Command tables For a quick overview of available commands, the commands are listed in a table before they are described. Except for the high-level measurement commands and the STATus commands, these tables contain the following four columns.

Command: The commands and their hierarchical order (see indentations).

Parameter: Required parameters.

Unit: Basic unit of physical parameters.

Remark: This column indicates which commands
- do not have a query form
- are available as a query only

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

Example:
`SENSe[1..4]:AVERage:COUNt` is shown in the table as follows:

```
SENSe[1..4]  first level
   :AVERage  second level
      :COUNt     third level
```

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

[1 to 4] or [1 to 8] This notation indicates the numeric suffix of a command. With the SENSe commands the suffix may assume the values 1 to 4; with the CALCulate and high-level measurement commands the values 1 to 8. If the suffix is not specified, it is internally set to 1.

[ ]

Keywords and parameters in square brackets may be omitted in compound commands. This will not change the meaning of the command. 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 keywords.

For instance, the following commands are identical:

```
[SENSe[1..4]]
  :CORRection
    :GAIN2
      [:INPut][:MAGNitude] 1

SENSe1:CORRection:GAIN2:INPut:MAGNitude 1
SENSe1:CORRection:GAIN2:INPut 1
SENSe1:CORRection:GAIN2 1
SENSe:CORRection:GAIN2 1
:CORRection:GAIN2 1
```

[?]
?

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

Example:
`[SENSe[1..4]]:POWer[:AVG]:APERture[?]`
`SENS1:POW:AVG:APER 1ms` sets the integration time in the ContAv mode to 1 ms.
`SENS1:POW:AVG:APER?` returns the currently set integration time.
`SYSTem:SENSor3:INFO?` queries information of sensor C which cannot be modified. For this reason, this command is only available as a query.

|
(for commands)

A selection of keywords with an identical effect exists for several commands. These keywords are entered in the same line and separated by a vertical bar. Only one of these keywords has to be indicated in the header of the command. The effect of the command is independent of the keyword entered.

Example:
`SENSe[1..4]` first level
`:FREQuency` second level
`[:CW|:FIXed]` third level

`SENSe[1..4]:FREQuency:CW 1E6` is equivalent to
`SENSe[1..4]:FREQuency:FIXed 1E6`

|
(for parameters)

A vertical bar in the notation of parameters is used to separate alternative options and is to be seen as an "or". The effect of the command differs depending on the parameter stated.

Example:
Selection of parameter for the command `INITiate:CONTinuous ON | OFF`
`ON` or `OFF` can be specified as a parameter.

{ }

Parameters in braces may be included in the command once, several times or not at all.

Types of Parameters

<NR1>

Stands for integers with sign.

Examples:
- 1
- -33
- 32767

<NRf>

Stands for floating point numbers that can also be written in exponential notation.

Examples:
- 1
- 1.0
- -21.2345553e-6

<int_value>

Is an abbreviation for `<NR1>|MINimum|MAXimum|DEFault`.

<float_value>

Is an abbreviation for `<NRf>|MINimum|MAXimum|DEFault`.

<boolean>

Stands for `ON|OFF|0|1`, where `ON` and `1` are identical in meaning as are `OFF` and `0`.

<string>

Stands for character strings that have to be within single or double quotes.

Examples:
- 'Harry Potter'
- "Sirius Black"

<block_data>

Stands for block data (→ section "Parameters" on page 5.11).

<non-decimal_numeric>

Is a non-decimal value in one of the following representations:
- binary (e. g. `#b0111010101001110` or `#B0111010101001110`)
- hexadecimal (e.g. `#h754e` or `#H754E`)
- octal (e.g. `#q72516` or `#Q75216`)

Common Commands to IEEE 488.1

The following messages are interface commands developed for the IEC/IEEE bus, which can be sent when the ATN line is active (→ section "IEC/IEEE Bus Interface", page 6.104).

DCL - Device CLear

All commands and messages in progress are aborted. The TRIGger system goes to the IDLE state, input and output queues are cleared, and the parser is reset and waits for the beginning of a new command. When INITiate:CONT ON is set, a new measurement is started. This command makes the device ready to receive commands.

GTL - Go To Local

The device is set to local mode and can again be operated manually.

LLO - Local Lock Out

This command deactivates the LOCAL key. When the LOCAL key is deactivated, the device can only be reset to the LOCAL mode by remote control (command GTL) or by switching the R&S NRP on/off.

PPC - Parallel Poll Configure

Sets the device to the "Parallel Poll Addressed to Configure State" (PACS).

PPD - Parallel Poll Disable

In the PACS, the parallel poll function is deactivated with PPD.

PPE - Parallel Poll Enable

In the PACS, the parallel poll function is activated with PPE and the bit position and the sense bit are set.

PPU - Parallel Poll Unconfigure

This command deactivates the parallel poll function without previous addressing.

SDC - Selected Device Clear

Same as DCL except that it applies to all devices that are currently in the listen mode.

SPD - Serial Poll Disable

Terminates the serial poll mode.

SPE - Serial Poll Enable

Activates the serial poll mode. When addressed as a talker, the device sends the status byte.

Common Commands to IEEE 488.2

The Common Commands to IEEE 488.2 are device commands that can be sent via the IEC/IEEE bus.

*CLS - CLear Status

Clears the status of the R&S NRP by resetting the following registers:

- Status byte register
- Standard event status register
- Error / event queue
- All SCPI status registers

Note: *The enable and transition registers (NTRansition and PTRansition) are not changed!*

*ESE 0..255 - Standard Event Status Enable

Sets the ENABle register of the Standard Event Status Register (ESR) to the specified value(→ SCPI command STATus, page 5.14).

*ESE? - Standard Event Status Enable Query

Returns the content of the ENABle register of the Standard Event Status Register→ SCPI command STATus, page 5.14).

*ESR? - Standard Event Status Register Query

Returns the content of the EVENt register of the Standard Event Status Register→ SCPI command STATus, page 5.14).

*IDN? - IDeNtification Query

Returns a string with information on the R&S NRP identity (device identification code). The string has the following format `<string1>,<string2>,<string3>,<string4>.`

Definition of string components:

<string1>	designation
<string2>	manufacturer
<string3>	serial number of the R&S NRP
<string4>	firmware version

*IST? - Individual Status Query

Returns the current value of the IST flag. The IST flag is described in section → "IST Flag and Parallel Poll Enable Register (PPE)" on page 6.60.

*OPC - OPeration Complete

Sets the operation complete bit in the Standard Event Status Register as soon as all currently executed commands have been completed.

*OPC? - OPeration Complete Query

The R&S NRP writes a "1" into the output queue and sets the operation complete bit in the Standard Event Status Register as soon as all currently executed commands have been completed. This bit may be used to trigger a service request.

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 avoids an overflow of the input queue when too many commands are sent that cannot be executed.

*OPT? - OPTion Query

Returns a string to the output queue containing information about all options installed.

Option	Response string
1	"NRP-B1: Test generator installed"
2	"NRP-B2: Second channel interface installed"
3	"NRP-B3: Battery installed"
4	"NRP-B4: Ethernet interface installed"
5	"NRP-B5: Four channel interface installed"
6	"NRP-B6: Sensor A/B rear socket"

*PRE 0..255 - Parallel Poll Enable Register Command

Sets the Parallel Poll Enable Register to the defined value.

*PRE? - Parallel Poll Enable Register Query

Returns the current content of the Parallel Poll Enable Register.

*PSC 0|1 - Power On Status Clear Command

Determines whether the content of the ENABle registers is retained or cleared upon power-up.

***PSC 0** causes the status registers to retain their content. With appropriate configuration of the ESE and SRE status registers, a service request may be triggered upon power-up.

***PSC 1** clears the registers.

*PSC? - Power On Status Clear Query

The query *PSC? reads out the content of the power-on-status-clear flag. The response can be "0" or "1" .

*RCL 0..19 - Recall

Calls the device state which has been stored with the *SAV command under the indicated number. The effect of *RCL 0 to 19 is the same as if one of the setups 0 to 19 had been selected in manual control. *RCL 0 resets the device to the default state.

*RST - Reset

Sets the device to the defined default state and has the same effect as the SCPI command SYSTem:PRESet. (Table 6-30). The table also provides default settings.

*SAV 1..19 - Save

Stores the current device state under the indicated number.

*SRE 0..255 - Service Request Enable

Sets the Service Request Enable Register bits. This command determines the conditions under which a service request is triggered.

*SRE? - Service Request Enable Query

Returns the value of the Service Request Enable Register.

*STB? - Status Byte Query

Returns the current value of the Status Byte Register.

*TRG - Trigger

Triggers a BUS event. If the sensor is in the WAIT_FOR_TRG state and the source for the trigger source is set to BUS (`TRIG:SOUR BUS`), the sensor enters the MEASURING state. *TRG invalidates all current measuring results. A query of measurement data following *TRG will thus always return the measured value determined in response to *TRG.

Error messages:

-211 "**Trigger ignored**": No sensor is in the WAIT_FOR_TRG state.
-211 "**Trigger ignored**": A sensor is in the WAIT_FOR_TRG state but the trigger source is not BUS.

*TST? - Self Test Query

Triggers a selftest and returns 0 (no error found) or 1 (an error has occurred).

*WAI - Wait

Prevents the execution of new commands until one of the following criteria is met:

- All previous commands have been executed.
- A `DCL` command is received.
- The device is switched off and on again (power-on-reset).

SCPI Commands

Overview of Command Systems

The SCPI commands described below are grouped in command systems according to their function. Only the most important functions are shown in the figures.

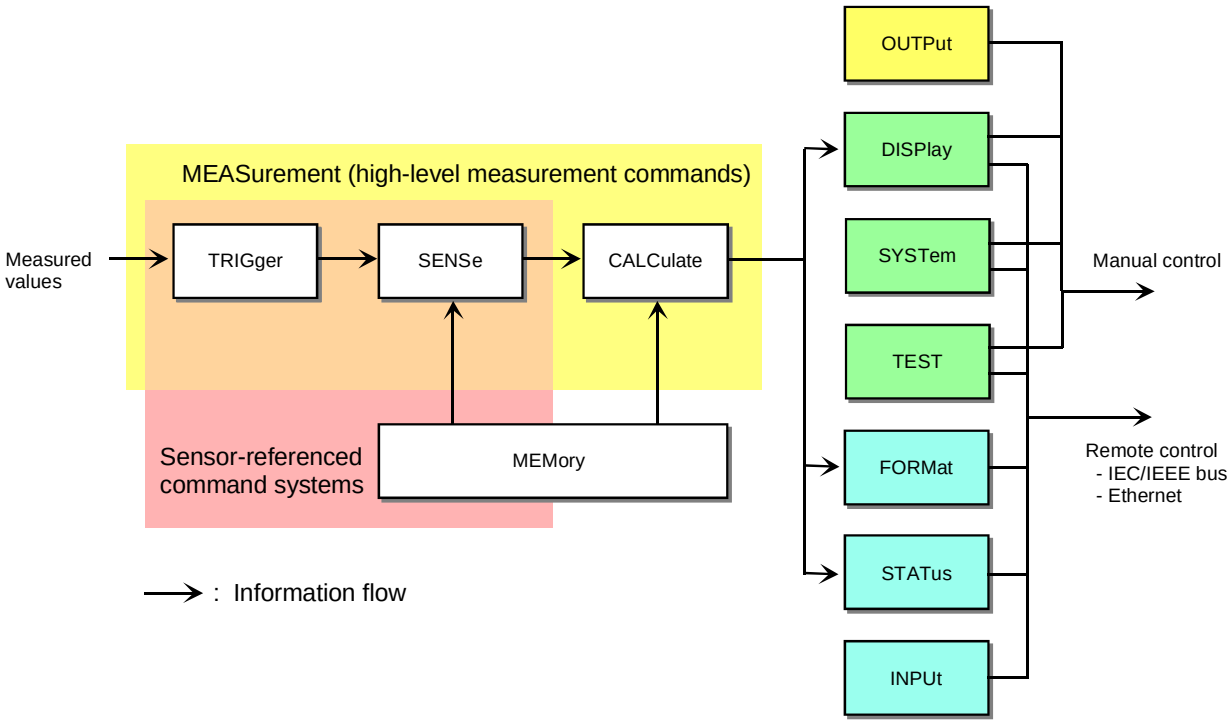

Fig. 6-1: Overview of SCPI command systems and their mutual interaction

Fig. 6-1 gives an overview of the SCPI command systems of the R&S NRP. The measured values provided by the TRIGger system are forwarded to the SENSe block where they are processed and handed to the CALCulate blocks. The values from the SENSe block are not immediately made available to the user, but only after they have been processed in the CALCulate blocks. In the CALCulate blocks, the values of several sensors can be processed together before they are output. MEASurement commands may be used to configure SENSe and CALCulate blocks with a single command. This may considerably simplify operation of the R&S NRP. The frequency-dependent correction tables for the measured values are managed by the MEMory command system. The other command systems have the following functions:

`OUTPut`: Switch on/off and calibration of test generator.

`DISPlay`: Configuration of result display within the display of the R&S NRP.

`SYSTem`: Different system settings regarding the operation of the R&S NRP.

`TEST`: Activation of sensor selftest.

`FORMat`: Setting of data format on remote control interfaces.

`STATus`: Configuration and query of Status Reporting Systems (→ page 5.14).

SENSe System

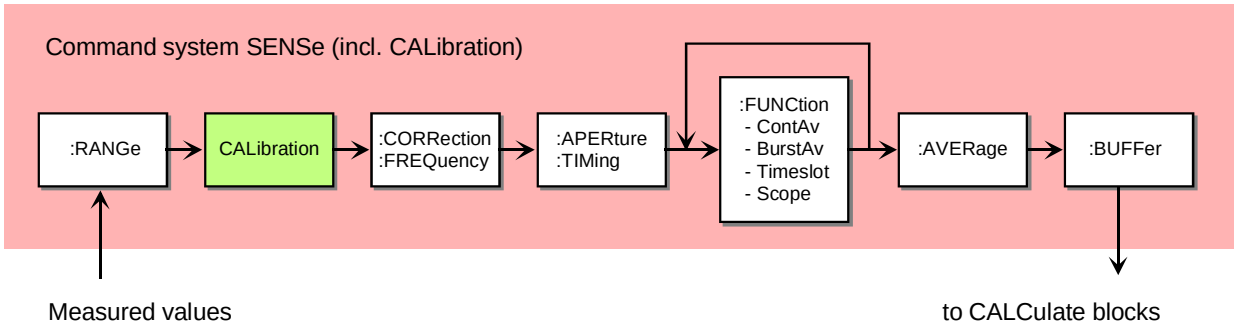

Fig. 6-2: SENSe system

This command system is used for configuring the sensors and determines the processing of measured data in the sensors. The blocks have the following functions:

:RANGe	Shifts the range boundaries to increase the measurement accuracy.
CALibration	Is a command system of its own and responsible for sensor calibration.
:CORRection :FREQuency	Corrects measured values in three steps (fixed offset value, frequency-dependent offset value and duty cycle).
:APERture :TIMing	Determines the timeslot in which power values are averaged.
:FUNCtion	Determines a measurement mode.
:AVERage	Filters the measured values.
:BUFFer	Stores the measured values temporarily to optimize the speed of data transmission to the remote controller.

CALCulate System

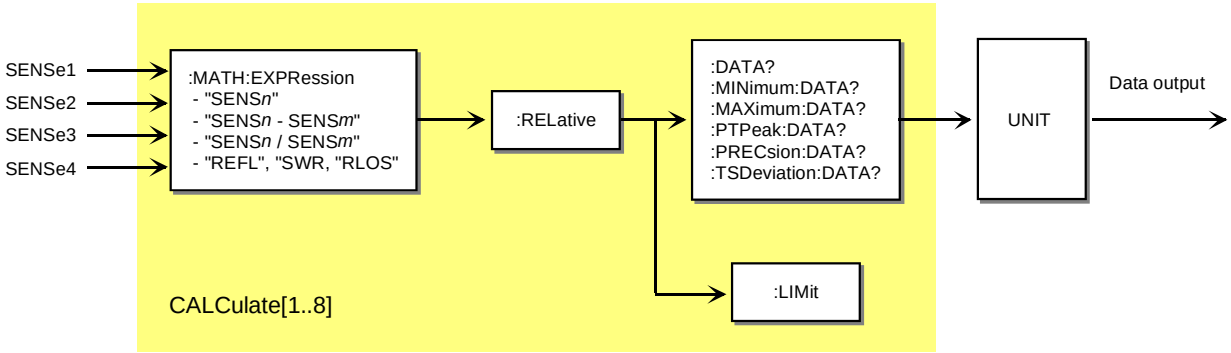

Fig. 6-3: Command system CALCulate

Eight CALCulate blocks are available to process the data supplied by the sensors. These blocks process the results of up to 2 sensors (primary and secondary channel) together. A calculation function can be selected for this purpose with the aid of :MATH:EXPRession. The result can then be correlated to a reference value (:RELative) before it is made available to the user by the UNIT block. Measured values can be monitored with the :LIMit commands.

High-Level Measurement Commands (CONFigure, MEASure, READ and FETCh)

The high-level measurement commands CONFigure, MEASure, READ and FETCh combine several setting commands and thus simplify programming of the R&S NRP. All settings of the SENSe and CALCulate blocks, which are not set by means of transferred parameters, are set to default values. The most convenient command is MEASure. This command configures sensors and calculate blocks, triggers a measurement and provides measurement results. The other commands perform only portions of these functions and thus allow the user to make specific modifications between the individual steps.

Strictly speaking, the CONFigure command is not a measurement command because it does not yield data and only configures a measurement. It differs from the other three high-level measurement commands as follows: a question mark at the end of the command provides information on current settings. With other commands, the question mark is compulsory and shows that the measured data is queried.

The commands have different functions:

CONFigure:... The calculate blocks and the associated sensors are configured by means of the parameter list. A measurement is not started. A question mark at the end of the command provides information on the (string) parameter last transferred. Since the device settings can be changed after a CONFigure, the query does not return the current device setup. CONFigure is performed internally by SENSe and CALCulate commands. One or several measurement channels are configured as follows:

Measurement mode:	ContAv	BurstAv	Timeslot	Scope
INIT:CONT	OFF	OFF	OFF	OFF
TRIG:SOUR	IMM	-	EXT	IMM
TRIG:COUN	1	1	1	1
TRIG:DEL:AUTO	ON	ON	ON	ON
SENS:AVER:COUN:AUTO	ON	ON	ON	ON
SENS:AVER:STAT	ON	ON	ON	ON
UNIT:POW UNIT:RAT	Is set as a function of the selected calculation function.			

FETCh:...? The last valid result is returned. The command is only completed after a valid measurement has been performed. When BUS is set as the trigger source, a measurement cannot be started after the FETCh command and an SCPI error is output (-214, Trigger deadlock).

In compliance with SCPI 1999.0, different results can be queried with FETCh without having to restart a measurement. This is only possible if the SENSe block is not reconfigured. This is the case if only the calculation function (e.g. :RATio:RELative) changes. In all other cases, an SCPI error (-221, Setting conflict) is returned and the command aborted.

READ:...? A measurement is started without further configuration and the measurement result is returned. The parameter list is compared to the current settings before the measurement is started. If the list does not agree, an SCPI error (-221, Setting conflict) is returned and the command aborted. Apart from this check, READ corresponds to the program message INIT:IMM; FETCh[1..8]:...?

MEASure:...? Combines CONFigure and READ.

FETCh? The FETCh? command without parameters has a special meaning. While suppressing parameters normally means that default values are used and checked, the current measured value under FETCh? is supplied when it is valid. If a measured value is not yet available, processing is suspended until a valid result is available.

READ? Can be compared with FETCh?. READ?; starts a measurement and returns a measured value without checking the current settings.

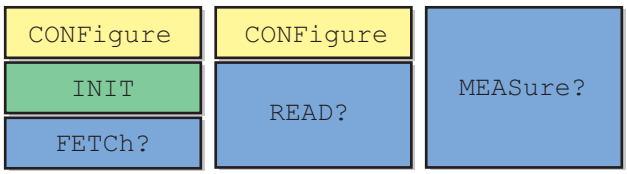

Fig. 6-4: Relationship between the commands CONFigure, READ?, FETCh? and MEASure?

Syntactical Structure of High-Level Measurement Commands

The high-level measurement commands can be divided as follows:

<head><function><expression>[?] <parameter_list>

<head>	CONFigure[1..8], READ[1..8], MEASure[1..8], FETCh[1..8]
<function>	Selection of one of the measurement modes ContAv, ContAv with data buffering, BurstAv, Timeslot or Scope. (→SENSe[1..4]:FUNCtion command on page 6.42).
<expression>	Specification of a calculation function for the addressed CALCulate block (→ CALCulate[1..8]:MATH:EXPRession command on page 6.23).
[?]	Queries must be terminated with an "?".
<parameter_list>	A list with parameters whose meaning is determined by the selected <function>.

Since all four high-level measurement commands use the same parameter lists, they are described together in this section.

Table 6-1: High-level measurement commands

CONFigure commands	Measurement commands	Parameters
CONFigure[1..8]?	FETCh[1..8]? READ?	
ContAv mode		
CONFigure[1..8]	READ[1..8] | MEASure[1..8] | FETCh[1..8]	
[:SCALar]	[:SCALar]	
[:POWer]	[:POWer]	
[:AVG]	[:AVG]?	<contav_parameter_list>
:RELative	:RELative?	<contav_parameter_list>
:DIFFerence	:DIFFerence?	<contav_parameter_list>
:RELative	:RELative?	<contav_parameter_list>
:RATio	:RATio?	<contav_parameter_list>
:RATio:RELative	:RATio:RELative?	<contav_parameter_list>
:SWR	:SWR?	<contav_parameter_list>
:REFLection	:REFLection?	<contav_parameter_list>
:RLOSs	:RLOSs?	<contav_parameter_list>
Timeslot mode		
CONFigure[1..8]	READ[1..8] | MEASure[1..8] | FETCh[1..8]	
[:SCALar]	[:SCALar]	
[:POWer]:TSLot	[:POWer]:TSLot	
[:AVG]	[:AVG]?	<timeslot_parameter_list>
:RELative	:RELative?	<timeslot_parameter_list>
:DIFFerence	:DIFFerence?	<timeslot_parameter_list>
:RELative	:RELative?	<timeslot_parameter_list>
:RATio	:RATio?	<timeslot_parameter_list>
:RATio:RELative	:RATio:RELative?	<timeslot_parameter_list>
BurstAv mode		
CONFigure[1..8]	READ[1..8] | MEASure[1..8] | FETCh[1..8]	
[:SCALar]	[:SCALar]	
[:POWer]:BURSt	[:POWer]:BURSt	
[:AVG]	[:AVG]?	<burst_parameter_list>
:RELative	:RELative?	<burst_parameter_list>
:DIFFerence	:DIFFerence?	<burst_parameter_list>
:RELative	:RELative?	<burst_parameter_list>
:RATio	:RATio?	<burst_parameter_list>
:RATio:RELative	:RATio:RELative?	<burst_parameter_list>
ContAv mode (with data buffering)		
CONFigure[1..8]	READ[1..8] | MEASure[1..8] | FETCh[1..8]	
:ARRay	:ARRay	
[:POWer]	[:POWer]	
[:AVG]	[:AVG]?	<buffered_parameter_list>
:RELative	:RELative?	<buffered_parameter_list>
:DIFFerence	:DIFFerence?	<buffered_parameter_list>
:RELative	:RELative?	<buffered_parameter_list>
:RATio	:RATio?	<buffered_parameter_list>
:RATio:RELative	:RATio:RELative?	<buffered_parameter_list>
Scope mode		
CONFigure[1..8]	READ[1..8] | MEASure[1..8] | FETCh[1..8]	
:XTIMe	:XTIMe	
[:POWer]	[:POWer]?	<scope_parameter_list>

Calculation Functions

The CALCulate blocks receive measurement data from the sensors via input channels which are called primary and secondary channel. The following functions are available for calculating the primary channel (PC) and the secondary channel (SC).

One-parameter functions (<source_list> = (@*n*); *n* = 1,2,3,4)

- *PC*
Yields the measured average power of the sensor assigned to the PC.

:RELative *PC / reference value*
The value measured in the PC is divided by the reference value determined with the aid of one of the following commands: CALCulate[1..8]:RELative[:MAGNitude] CALCulate[1..8]:RELative:AUTO.

Two-parameter functions (<source_list> = (@*n*),(@*m*); *n* = 1,2,3,4; *m* = 1,2,3,4)

:DIFFerence *PC - SC*
Yields the difference between the PC and SC. This means that two sensors must be specified in <source_list>. This also applies to the following functions.

:DIFFerence:RELative *(PC - SC) / reference value*
The difference between the PC and SC is divided by the reference value determined with the aid of one of the following commands: CALCulate[1..8]:RELative[:MAGNitude] CALCulate[1..8]:RELative:AUTO.

:RATio *PC / SC*
Yields the ratio of PC to SC.

:RATio:RELative *(PC / SC) / reference value*
The ratio of the PC and SC is divided by the reference value determined with the aid of one the following commands: CALCulate[1..8]:RELative[:MAGNitude] CALCulate[1..8]:RELative:AUTO.

:SWR $\frac{1+\sqrt{SC/PC}}{1-\sqrt{SC/PC}}$
If the forward power of a wave is measured in the PC and the reflected power in the SC, the measurement command yields the standing wave ratio. The output unit is set to percent (UNIT:RAT PCT).

:REFLection

$\sqrt{SC/PC}$

If the forward power of a wave is measured in the PC and the reflected/transmitted power in the SC, the calculate block yields the reflection coefficient/transmission factor of the DUT. The output unit is set to percent (`UNIT:RAT PCT`).

:RLOSs

$-20\log_{10}\sqrt{SC/PC}$

If the forward power of a wave is measured in the PC and the reflected or transmitted power in the SC, the calculate block yields the return loss/transmission loss of the DUT.

This function principally yields the same result as the `:RATio` function. The only difference is the output unit which is automatically set to `dB` by means of this command (`UNIT:RAT DB`).

Parameters

Five different parameter lists are used in the command table, depending on the selected measurement mode. The elements of these lists can be omitted starting at the end and working backward. They will then be replaced by their default values. The parameter lists are defined as follows:

ContAv mode	<contav_parameter_list>	[<expected_value> [,<resolution>]] [,<source_list>]
Timeslot mode	<timeslot_parameter_list>	<tslot_width>, <no_slots>, <start_exclude> , <end_exclude> [,<expected_value> [,<resolution>]] [,<source_list>]
BurstAv mode	<burst_parameter_list>	<dtolerance>, <start_exclude> , <end_exclude> [,<expected_value> [,<resolution>]] [,<source_list>]
ContAv mode (with data buffering)	<buffered_parameter_list>	(<buffered_size>), [<expected_value> [,<resolution>]] [,<source_list>]
Scope mode	<scope_parameter_list>	(<scope_size>), <capture_time> [,<source_list>]

The elements of the parameter lists have the following meaning:

<expected_value> Value range: <float_value> | DEF
According to the SCPI-1999.0 standard, a value in the order of the expected measured value can be specified. This allows the device to set an adequate measurement range. This is not required in the R&S NRP because the measurement is performed simultaneously in all measurement ranges. Any value can therefore be specified for the <expected_value> parameter, especially the DEFault value. The value is always ignored.

<resolution> Value range:1 | 0.1 | 0.01 | 0.001 |
1 | 2 | 3 | 4
Default value: 3 (0.01)
Specifies the limit up to which the measurement result should be free of noise. The R&S NRP tries to set an adequate window for the averaging filter. This does not affect the accuracy of the measured data. The window can only be set if automatic setting of the filter window has not been disabled by the user (SENSe:AVERage:COUNt:AUTO OFF). Since the automatic setting is activated by CONF as a default, the user normally does not need to alter this setting.

→ `[SENSe[1..4]]:AVERage:COUNt:AUTO:RESolution[?] 1 | 2 | 3 | 4`,

→ `[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:RESolution[?] 1|2|3|4` and

→ `DISPlay[:WINDow][1..4]:RESolution[?] 1 | 0.1 | 0.01 | 0.001`

Example:
If `<resolution>` is set to `3` or `0.01`, three significant points are assigned to the value when it is displayed on a linear scale. When a log scale is used, 2 places are displayed after the decimal point.

<source_list>

Value range: `(@n) | (@n),(@m)`
Default value: `(@1)` or `(@1),(@2)`
n and *m* may assume the values 1, 2, 3 or 4.

With this list, sensors are assigned to the primary and possibly to the secondary channel of a calculate block. The number for each sensor is preceded by the character @ and the entire expression is enclosed in parentheses.

Example:
`(@1)`is used for sensor A.

Example:
The values `@3),(@2)` are set for `<source_list>`. Sensor C is assigned to the primary channel and sensor B to the secondary channel. The calculate blocks process the primary channel together with the secondary depending on the desired function. If `:RATio` is selected as the calculation function, the result from the calculate block is the ratio of the values measured by sensor C and sensor B.

<tslot_width>

Value range: depending on sensor.
Default value: depending on sensor.
Unit: S
Width of a timeslot in the Timeslot mode.
→ `[SENSe[1..4]][:POWer]:TSLot:[AVG]:WIDTh[?] <float_value>`

<no_slots>

Value range: depending on sensor.
Default value: depending on sensor.
Unit: -
Number of timeslots to be measured in the Timeslot mode.
→ `[SENSe[1..4]][:POWer]:TSLot:[AVG]:COUNt[?] <int_value>`

<start_exclude>
<end_exclude>

Value range: depending on sensor.
Default value: depending on sensor.
Unit: S
Amount of time at the beginning and the end of a timeslotor integration period that should not be taken into account.
→ `[SENSe[1..4]]:TIMing:EXCLude:STARt[?] <float_value>`
and
→ `[SENSe[1..4]]:TIMing:EXCLude:STOP[?] <float_value>`

<dtolerance> Value range: depending on sensor.
Unit: S
Default value: depending on sensor.
The length of a time interval in which the power level may drop below the trigger level without the end of a power pulse being detected.
→`[SENSe[1..4]][:POWer]:BURSt[:AVG]:DTOLerance[?] <float_value>`

<capture_time> Value range: depending on sensor.
Unit: S
Default value: depending on sensor.
Period within which measured data are captured in the Scope mode.
→ `[SENSe[1..4]]:SWEep:TIME[?] <float_value>`

(<buffered_size>) Value range: depending on sensor.
Default value: depending on sensor.
Unit: -
Number of requested measured values.
→ `[SENSe[1..4]][:POWer][:AVG]:BUFFer:SIZE[?] <int_value>`

(<scope_size>) Value range: depending on sensor.
Default value: depending on sensor.
Unit: -
Number of measured values in one data set.
→ `[SENSe[1..4]]:SWEep:POINts <int_value>`

Error messages

24 "**Sensor mode not supported**": A sensor does not support a measurement mode.

-221 **"Settings conflict"**: This error is generated when a `FETCH` or `READ` command is sent and the current device settings do not correspond to the transmitted parameters. The parameters transmitted in these two commands are not used for device configuration but rather to check the settings.

-108 "**Parameter not allowed**": The parameter list contains unexpected parameter types or the parameters are not sent in the correct order.

-127 "**Invalid numeric data**": An invalid value was specified for `<resolution>`.

-171 "**Invalid expression**": Error in the `<source_list>` parameter. Two sensors were specified instead of one, or the specified sensor is not correct.

CALCulate (Configuration of Calculate Blocks)

The calculate blocks calculating the measurement results from the sensor data are configured with the CALCulate command. Eight blocks are available, each with two input channels (primary and secondary channel). The available sensors (1 to 4, depending on device configuration and connected sensors) can be assigned to the channels. With the aid of a selectable function (CALC:MATH), the channels can be processed together.

Table 6-2: Commands of the CALCulate system

Command	Parameter	Unit	Remark
CALCulate[1..8]			
:DATA?		W|DBM|PCT|DB	Query only
:MINimum:DATA?	-	W|DBM|PCT|DB	Query only
:MAXimum:DATA?	-	W|DBM|PCT|DB	Query only
:PTPeak:DATA?	-	W|DBM|PCT|DB	Query only
:EXTRemes:RESet	-		No query
:LIMit			
:BEEP	ON|OFF		No query
:CLEar[:IMMediate]	-		No query
:FAIL?	-		Query only
:FCOunt?	-		Query only
:UPPer			
[:DATA][?]	<float_value>	-	The value range of the parameter depends on the output unit of the measured value.
:STATe[?]	ON|OFF		
:LOWer			
[:DATA][?]	<float_value>	-	The value range of the parameter depends on the output unit of the measured value.
:STATe[?]	ON|OFF		
:MATH			
[:EXPRession][?]	<string>		
:CATalog?	-		Query only
:RELative			
[:MAGNitude][?]	<float_value>	-	The value range of the parameter depends on the output unit of the measured value.
:AUTO[?]	OFF|ONCE		
:POWer[:MAGNitude][?]	<float_value>	DBM|W	
:RATio[:MAGNitude][?]	<float_value>	PCT|DB	
:STATe[?]	ON|OFF		

CALCulate[1..8][:MINimum | :MAXimum | :PTPeak]:DATA?

With this command the current output value of a calculate block can be queried.
If one of the optional keywords :MAXimum, :MINimum or :PTPeak is specified, other values can be queried instead of the current measured value.

:MAXimum
:MINimum
Maximum and minimum of all measured values that previously occurred in this calculate block. The two limit values are set to the current measured value when
- the device is switched on
- a reset is performed (*RST)
- the values are explicitly set to the current measured value using the command CALCulate[1..8]:EXTRemes:RESet.

:PTPeak
Peak-to-peak distance (maximum - minimum) of measured values in the calculate block.

Unit: → Table 6-3 on page 6.24.

CALCulate[1..8]:EXTRemes:RESet

The R&S NRP stores the maximum and minimum values of each measurement for each calculate block. The current measured value is stored with CALC[1..8]:EXTR:RES as the new minimum and maximum value. The extreme values can be queried with CALC[1..8]:MIN:DATA? and CALC[1..8]:MAX:DATA?.

CALCulate[1..8]:LIMit:BEEP ON | OFF

Switches the acoustic warning for limit violations on or off.

***RST value:** OFF

CALCulate[1..8]:LIMit:CLEar[:IMMediate]

Resets the limit monitoring state and the internal counter for limit violations.

CALCulate[1..8]:LIMit:FAIL?

Queries whether upper or lower limits have been exceeded. The status is reset by the following events (0 = no limit violation):

- The device is switched on
- A reset is performed (*RST)
- The CALCulate[1..8]:LIMit:CLEar command is sent.

CALCulate[1..8]:LIMit:FCOunt?

This query returns the number of limit violations that occurred. The counter is zeroed when the following events occur:

- The device is switched on
- A reset is performed (*RST)
- The CALCulate[1..8]:LIMit:CLEar command is sent.

CALCulate[1..8]:LIMit:UPPer[:DATA][?] <float_value>

This command sets an upper limit for the measured values. The R&S NRP can respond when this limit is exceeded (see other CALCulate[1..8]:LIMit commands).

The value range depends on the current output unit of the measured value of the calculate block.

Unit of measured value	W	DBM	PCT	DB
Value range for <float_value>	1e-18..1e18	-150..210	1e-18..1e22	-200..200

Unit: → Table 6-3 on page 6.24.
***RST value:** 0 DBM or 0 DB

CALCulate[1..8]:LIMit:UPPer:STATe[?] ON | OFF

This command switches the monitoring function for the upper limit on or off.

***RST value:** OFF

CALCulate[1..8]:LIMit:LOWer:DATA[?] <float_value>

This command sets a lower limit for the measured values. The R&S NRP can respond when values are below this limit (see other CALCulate[1..8]:LIMit commands).

The unit of the parameter is determined according to Table 6-3.

The value range depends on the current output unit of the measured value of the calculate block.

Unit of measured value	W	DBM	PCT	DB
Value range for <float_value>	1e-18..1e18	-150..210	1e-18..1e22	-200..200

Unit: → Table 6-3 on page 6.24.
***RST value:** 0 DBM or 0 DB

CALCulate[1..8]:LIMit:LOWer:STATe[?] ON | OFF

This command switches the monitoring function for the lower limit on or off.

***RST value:** OFF

CALCulate[1..8]:MATH[:EXPRession][?] <string>

The <string> parameter may assume the following values (1, 2, 3 and 4 for *n* and *m*). A sensor must be connected to the respective channel.

<string>	Meaning
"(SENS1)" "(SENS2)" "(SENS3)" "(SENS4)"	The calculate block outputs the measured value of sensor A. The calculate block outputs the measured value of sensor B. The calculate block outputs the measured value of sensor C. The calculate block outputs the measured value of sensor D.
"(SENS*n*-SENS*m*)"	The calculate block outputs the difference between the measured values of sensor *n* and sensor *m*.
"(SENS*n* /SENS*m*)"	The calculate block outputs the quotient of the values measured by sensor *n* and *m*.
"SWR(SENS*n*,SENS*m*)"	$\frac{1+\sqrt{SENSm / SENSn}}{1-\sqrt{SENSm / SENSn}}$ If sensor *n* measures the forward power of a wave and sensor *m* the reflected power, the calculate block outputs the standing wave ratio of this wave. The output unit is set to percent (UNIT:RAT PCT).
"REFL(SENS*n*,SENS*m*)"	$\sqrt{SENSm / SENSn}$ If sensor *n* measures the forward power of a wave and sensor *m* the reflected/transmitted power, the calculate block outputs the reflection coefficient/transmission factor of a DUT. The output unit is set to percent (UNIT:RAT PCT).
"RLOS(SENS*n*,SENS*m*)"	$-20 \log_{10} \sqrt{SENSm / SENSn}$ If sensor *n* measures the forward power of a wave and sensor *m* the reflected/transmitted power, the calculate block outputs the return loss/transmission loss of a DUT. This function principally supplies the same result as the (SENS*n*/SENS*m*) function. The difference is that the output unit is automatically set to dB. (UNIT:RAT DB).

This command selects a measurement function that processes one sensor or two together. The result of this calculation is made available as a measured value and can be queried with FETch[1..8]? or CALCulate[1..8]:DATA?.

***RST value:** CALC1:MATH "(SENS1)",
CALC2:MATH "(SENS2)",
CALC3:MATH "(SENS3)",
CALC4:MATH "(SENS4)",
CALC5:MATH "(SENS1)",
CALC6:MATH "(SENS1)",
CALC7:MATH "(SENS1)",
CALC8:MATH "(SENS1)".

Error messages:

-151 "**Invalid string data**": An invalid <string> parameter was transmitted.

CALCulate[1..8]:MATH[:EXPRession]:CATalog?

Lists all supported calculation functions. All functions are sent in the form of strings which are allowed as parameters for the CALCulate[1..8]:MATH:EXPRession command.

CALCulate[1..8]:RELative[:MAGNitude][?] <float_value>

This command determines a value that is used as a divisor (logarithmic subtraction) for all measured values of the calculate block in the CALC:REL:STAT ON state. The unit of this value is equal to the unit of the output value of the calculate block and is defined according to Table 6-3:

Table 6-3: Output unit of measured value of calculate block.

CALC:MATH?	CALC:REL:STAT OFF		CALC:REL:STAT ON	
	UNIT:POW W UNIT:RAT PCT	UNIT:POW DBM UNIT:RAT DB	UNIT:POW W UNIT:RAT PCT	UNIT:POW DBM UNIT:RAT DB
"(SENS*n*)"	W	DBM	PCT	DB
"(SENS*n*-SENS*m*)"	W	DBM	PCT	DB
"(SENS*n*/SENS*m*)"	PCT	DB	PCT	DB
"SWR(SENS*n*,SENS*m*)"	PCT	DB	PCT	DB
"REFL(SENS*n*,SENS*m*)"	PCT	DB	PCT	DB
"RLOS(SENS*n*,SENS*m*)"	PCT	DB	PCT	DB

The value range depends on the current output unit of the measured value of the calculate block.

Unit of measured value	W	DBM	PCT	DB
Value range for <float_value>	1e-18 to 1e18	-150 to 210	1e-18 to 1e22	-200 to 200

Unit: → Table 6-3.
***RST value:** 0 DBM or 0 DB

CALCulate[1..8]:RELative[:MAGNitude]:POWer[?] <float_value>

Has the same direct effect as CALC:REL on the reference value for measured values that share the unit of a power.

Unit: DBM | W
Default unit: DBM
Value range: 1e-18..1e18 W | -150..210 DBM
***RST value:** 0 DBM

CALCulate[1..8]:RELative[:MAGNitude]:RATio[?] <float_value>

Has the same direct effect as CALC:REL on the reference value for measured values that share the unit of a power ratio.

Unit: DB | PCT
Default unit: DB
Value range: -200..200 DB | 1e-18..1e22 PCT
*RST value: 0 DB

CALCulate[1..8]:RELative[:MAGNitude]:AUTO[?] OFF | ONCE

Sets the current measured value as the reference value. When used as a setting command, this command can only be called by the parameter ONCE. OFF will be ignored. OFF is always returned in response to a query.

***RST value:** OFF

Error messages:

-230 "**Data corrupt or stale**": The current measured value is invalid.

CALCulate[1..8]:RELative:STATe[?] ON | OFF

Determines whether a reference value is used. If this command is called with ON, all results of the calculate block are divided by the reference value set with CALCulate[1..8]:RELative[:MAGNitude].

***RST value:** OFF

CALibration

Table 6-4: Commands of the CALibration system

Command	Parameter	Unit	Remark
CALibration[1..4|:ALL]			
:ZERO			
:AUTO[?]	OFF|ONCE		
:DATA[?]	<block_data>		

CALibration[1..4|:ALL]:ZERO:AUTO[?] OFF | ONCE

The CALibration[1..4]:ZERO:AUTO ONCE command performs zeroing using the signal at the sensor input. The sensor must be disconnected from all power sources. If the signal at the input considerably deviates from 0 W, an error message is issued and the command is aborted (SCPI error -231, "Data questionable; ZERO ERROR").

The setting command CAL[1..4]:ZERO:AUTO only accepts the parameters ONCE (starts zeroing) and OFF (will be ignored). A query always returns OFF.

Zeroing is recommended if

- the temperature has varied by more than about 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.

***RST value:** OFF

Error messages:

-224 "**Illegal parameter value**": The transfer parameter is a numeric value unequal 0 (corresponds to OFF).

CALibration[1..4|:ALL]:DATA[?] <block_data>

This command is used to read and write binary calibration data sets for the sensors.

DISPlay

The DISPlay command system is mainly used to configure the display of windows on the R&S NRP. The WINDow commands are assigned to the calculate blocks 1 to 4. The values calculated from the sensor values by the respective calculate block with the aid of the measurement function are displayed.

Table 6-5: Commands of the DISPlay system

Command	Parameter	Unit	Remark
DISPlay			
:ILLumination[?]	ON|OFF		
:MESSage			
[:STATe][?]	ON|OFF		
:TEXT			
:CLEar	-		No query
[:DATA]	<string>		No query
:TYPE	MESSage|QUERy		No query
:PIXMap?	-		Query only
[:WINDow][1..4]			
:FORMat[?]	DIGital|ANALog		
:METer | :ANALog			
:AUTo[?]	ONCE|OFF		
:LOWer[?]	<float_value>	-	The value range of the parameter depends on the output unit of the measured value.
:UPPer[?]	<float_value>	-	The value range of the parameter depends on the output unit of the measured value.
:NAME[?]	<string>		
:RESolution[?]	1|0.1|0.01|0.001	-	
:SELect[?]	-		
:SIZE[?]	NORMal|ZOOMed		
[:STATe][?]	ON|OFF		

DISPlay:ILLumination[?] ON | OFF

This command switches the display (actually the backlighting) (ON) or (OFF). Backlighting is switched on again in case of a reset.

***RST value:** ON

DISPlay:MESSage[:STATe][?] ON | OFF

Opens a window in the display with a text message that can be set with DISP:MESS:TEXT <string>. Two types of message windows are available which can be selected with DISP:MESS:TYPE.

***RST value:** OFF

DISPlay:MESSage:TEXT:CLEar

Clears the text stored for text messages displayed with DISP:MESS ON.

DISPlay:MESSage:TEXT [:DATA] <string>

Creates the text for text messages that can be displayed with DISP:MESS ON.

***RST value:** ""

DISPlay:MESSage:TYPE MESSage | QUERy

Determines the type of message that can be displayed with DISP:MESS ON.

MESSage Only the window with the message is shown. The window can be closed with the command DISP:MESS OFF.

QUERy The window can also be closed by pressing the (MENU↵) key.

***RST value:** MESSage

DISPlay:PIXMap? <block_data>

Supplies the display content as binary block data. The content is sent line by line with one bit corresponding exactly to one pixel.

Example:
DISP:PIXM? returns: #49600xxxxxx...x, with x in binary format comprising the display contents.

DISPlay[:WINDow[1..4]]:FORMat[?] DIGital | ANALog

Selects the display mode for measured data.

DIGital Measured values are displayed in numeric format.

ANALog Measured values are indicated by a marker on a scale. The values at the upper and lower scale end as well as the type of scaling (linear or logarithmic) are set with the following :METer commands.

***RST value:** DIGital

DISPlay[:WINDow[1..4]]:METer|:ANALog:AUTo[?] ONCE | OFF

DISP:AUTO ONCE automatically determines scaling for the analog display. The upper and the lower limit value of the display is set as a function of the current measurement data. Only the ONCE parameter is permissible; a query always supplies the value OFF.

***RST value:** OFF

DISPlay[:WINDow[1..4]]:METer|:ANALog:LOWer[?] <float_value>

Sets the lower limit value of the analog scale.

The value range depends on the current output unit of the measured value of the window.

Unit of measured value	W	DBM	PCT	DB
Value range for <float_value>	1e-18..1e18	-150..210	1e-18..1e22	-200..200

Unit: → Table 6-3 on page 6.24.
***RST value:** -90 DBM or -120 DB

DISPlay[:WINDow[1..4]]:METer|:ANALog:UPPer[?] <float_value>

Sets the upper limit value of the analog scale.

The value range depends on the current output unit of the measured value of the window.

Unit of measured value	W	DBM	PCT	DB
Value range for <float_value>	1e-18..1e18	-150..210	1e-18..1e22	-200..200

Unit: → Table 6-3 on page 6.24.
***RST value:** 70 DBM or 60 DB

DISPlay[:WINDow][1..4]:NAME[?] <string>

Determines the string to be displayed in the respective window. The reset values depend on the window (<*n*> = 1, 2, 3 or 4).

***RST value:** ""

Example:
```
DISP1:NAME "Power In"
DISP2:NAME "Power Out"
```
The measured values in the display are now visually assigned to the different test points in the test setup. (Input power in window 1, output power in window 2).

DISPlay[:WINDow][1..4]:RESolution[?] 1 | 0.1 | 0.01 | 0.001

Specifies the number of significant places of the mantissa when the measurement result is displayed on a linear scale. The R&S NRP tries to adjust the averaging filter range so that the display noise decreases with increasing resolution. The values of the transfer parameter have the following meaning:

Parameter	Linear scale of measurement result	Logarithmic scale of measurement result
1	1 significant place	No decimal place
0.1	2 significant places	1 decimal place
0.01	3 significant places	2 decimal places
0.001	4 significant places	3 decimal places

Note: *Automatic filter ranging must be switched on (*`SENSe[1..4]:AVERage:COUNt:AUTO ON`*). DISP[1..8]:RES has an effect on the setting* `SENS[1..4]:AVER:COUN:AUTO:RES` *of the sensors used in the measurement function (*`CALC[1..8]:MATH`*). However, the resolution setting of the sensors does not affect the resolution of values in the display.*

This command corresponds to the `<resolution>` option of the high-level measurement commands `CONFigure`, `FETCH`, `READ` and `MEASure`.

***RST value:** `0.01`

Error messages:

-127 "**Invalid numeric data**": An invalid number was specified for the resolution.

Example:
`DISP:WIND1:RES 0.1`
With a measured value of 123.456789 W, the first two places are free of noise and thus 120 W is displayed.

DISPlay[:WINDow][1..4]:SELect[?]

Selects a window. In manual control, changes in the window configuration always apply to the active/selected window. For this reason, the setting is only of importance after a remote-to-local transition.

***RST value:** `1`

DISPlay[:WINDow][1..4]:SIZE[?] NORMal | ZOOMed

Setting the window size.

NORMal The window size is set automatically and depends on the number of windows opened.

ZOOMed Irrespective of the number of open windows, a window is expanded to maximum size. Other open windows will be obscured.

***RST value:** NORMal

DISPlay[:WINDow][1..4][:STATe][?] ON | OFF

Opens or closes a window. When a window is closed the other windows are automatically expanded so that the free space is utilized. Likewise, open windows become smaller when a new one is opened.

***RST value:** ON (Window 1)
OFF (Window 2,3,4)

MEMory

The MEMory system is used for storing device states (:STATe) and correction tables (:TABLe).

:STATe To allow a rapid and convenient changeover between device setups for different applications, up to 20 setups can be stored in the device. The setup with the number 0 is the default setup made in the factory. This setup can neither be changed nor cleared.

:TABLe Tables can be stored for a frequency-dependent correction of measured values. Up to 10 tables with two columns and up to 80 entries (lines) can be created. Thus, not only the sensors but also the frequency response of various test assemblies can be compensated for during the measurement.
The tables are selected with [SENSe[1..4]]:CORRection:FDOT[:SELect]and then activated and deactivated with
[SENSe[1..4]]:CORRection:FDOT[:SELect][?]:STATe.
Names can be assigned to the tables. Some commands which do not specify a table name affect the table currently selected with MEM:TABL:SEL <name>.

Note: *Stored data is not affected by an *RST command.*

Table 6-6: Commands of the MEMory system

Command	Parameter	Unit	Remark
MEMory			
:CATalog			
[:ALL]?	-		Query only
:STATe?	-		Query only
:TABLe?	-		Query only
:CLEar			
[:NAME]	<name>		No query
:TABLe	-		No query
:FREE			
[:ALL]?	-		Query only
:STATe?	-		Query only
:TABLe?	-		Query only
:NSTates?	-		Query only
:STATe			
:CATalog?	-		Query only
:DEFine[?]	<string>, 0..19		
:TABLe			
:FREQuency[?]	<NRf>{,<NRf>}	HZ	
:POINts?	-		Query only
:GAIN			
[:MAGNitude][?]	<NRf>{,<NRf>}	DB|PCT	
:POINts?	-		Query only
:MOVE	<string>,<string>		No query
:SELect[?]	<sting>		

MEMory:CATalog[:ALL]?

Lists the names of all stored device states and correction tables. The length of the response depends on how many device states and tables are stored. It has the following format:

<NR1>, <NR1> {,"<string>"}

The first two values denote the length in bytes of the occupied RAM and of the RAM still available for storing states and tables. These values are followed by a string for each stored state and then for each stored table; this string again consists of two strings and a numeric value:

<string>, <type>, <NR1>

<string> gives the name of the stored data item, <type> the type (TABL or STAT) and <NR1> the length of the data item in bytes.

Example:
The response to query MEM:CAT? could be:
956,99044,"REFL,STAT,408","NRPZ21,TABL,432","SPLITTER1,TABL,116"

MEMory:CATalog:STATe?

This query only gives a list of stored device states and is otherwise identical with MEMory:CATalog[:ALL]?.

MEMory:CATalog:TABLe?

This query only gives a list of stored correction tables and is otherwise identical with MEMory:CATalog[:ALL]?.

MEMory:CLEar[:NAME] <string>

Clears the content of the correction table or the stored device state with the designation <name>. The table is maintained but does not contain entries.

Caution: *This command cannot be cancelled. Cleared values are irretrievably lost.*

MEMory:CLEar:TABLe

This command may be used as an alternative to MEMory:CLEar[:NAME] <string>. The content of the table currently selected with MEMory:TABLe:SELect[?] <string> is cleared.

MEMory:FREE[:ALL]?

Returns the number of bytes available in memory for storing correction tables and device states as well as the memory already used.

MEMory:FREE:STATe?

Returns the number of bytes available in memory for storing device states as well as the memory already used for device states.

MEMory:FREE:TABLe?

Returns the number of bytes available in memory for storing device states as well as the memory already used for device states.

MEMory:NSTates?

Returns the number of storable device states. Since 20 device states can be stored, 20 is always returned.

MEMory:STATe:CATalog?

Returns a list of names of stored device states in the format

<string>{,<string>}

MEMory:STATe:DEFine <string>, 1..19
MEMory:STATe:DEFine? <string>

The value 0 to 19 are assigned to the memory locations of the device states, where the memory location with the number 0 is the factory-set state and cannot be changed. Names (<string>) can be assigned to these numbers with MEM:STAT:DEF (except for the factory-set state). The commands MEM:CAT, MEM:CAT:STAT and MEM:STAT:CAT expect parameter that are actually these numbers rather than the numbers of the memory locations. The default names of these memory locations are "Setup 0" to "Setup 19". The name may contain the characters A to Z, a to z, 0 to 9 and "_".
The query of this command returns the number of the memory location with the name of <string>.

MEMory:TABLe:FREQuency[?] <NRf>{,<NRf>}

This command enters frequencies in the first column of the table selected with MEM:TABL:SEL. Existing data for frequencies will be overwritten. The number of frequencies should match the number of offset values. If the number of frequencies differs from the number of offset values, the shorter column length will be used.

SENS[1..4]:FREQ can be used to determine a frequency for which a correction factor is then defined by means of the offset table. If the exact frequency selected is not in the table, the values in the table are interpolated. If the selected frequency is outside the specified frequency range, the maximum or minimum offset value of the table is selected. Interpolation is linear in the units HZ and DB.

Unit: HZ
***RST values:** Tables are not changed in case of a *RST.

MEMory:TABLe:FREQuency:POINts?

Returns the number of entries (lines) in the table selected with MEM:TABL:SEL <name>.

MEMory:TABLe:GAIN[:MAGNitude][?] <NRf>{,<NRf>}

This command enters offset values in the second column of the table selected with MEM:TABL:SEL. Existing data for offset values will be overwritten. The number of frequencies should match with the number of offset values. If the number of frequencies differs from the number of offset values, the shorter column length will be used.

A frequency can be determined with SENS[1..4]:FREQ, for which a correction factor is then calculated by means of the offset table. If the exact frequency selected is not in the table, the values in the table are interpolated. If the selected frequency is outside the specified frequency range, the maximum or minimum offset value of the table is selected. Interpolation is linear in the units HZ and DB.

Unit: DB | PCT
Default unit: DB
***RST values:** Tables are not changed in case of *RST.

MEMory:TABLe:GAIN:POINts?

Returns the number of entries (lines) in the table selected with MEM:TABL:SEL <string>.

MEMory:TABLe:MOVE <string>,<string>

With this command tables can be renamed. The first parameter specifies the old name, the second the new name.

Example:
The command MEM:TABL:MOVE "Table 1","Test setup" renames the table "Table 1" into "Test setup" .

MEMory:TABLe:SELect[?] <string>

Selects the table name < string>. The following commands affect this table:

- MEMory:CLEar[:NAMe] <string>
- MEMory:CLEar:TABLe
- all MEMory:TABLe commands

The selection is not changed in case of an *RST or a SYSTem:PRESet.

***RST value:** none

Error messages:

-256 "**File name not found**": A table named <string> is not known.

OUTPut

The OUTPut system serves for generator configuration. The R&S NRP can be equipped with an optional RF test generator which produces a reference power of 1 mW at 50 MHz. Moreover, the analog outputs can be configured at the rear of the power meter.

Table 6-7: Commands of the OUTPut system

Command	Parameter	Unit	Remark
OUTPut :ROSCillator [:STATe][?]	ON|OFF		Option R&S NRP-B1

OUTPut:ROSCillator[:STATe][?] ON | OFF

The command switches the optional RF generator (ON) or (OFF).

***RST value:** OFF

SENSe (Sensor Commands)

The commands of the SENSe group configure the power sensors with the exception of the trigger system. This includes the measurement modes (ContAv, BurstAv, Timeslot or Scope), the offset corrections and the filter settings.

Note: *When the sensors are connected to the R&S NRP, they inform the device about the SENSe and TRIGger commands supported and about the value ranges for parameters. This applies to both numeric and text parameters. For this reason, no fixed ranges are specified with these commands; the ranges can be obtained from the respective sensor manual.*

Table 6-8: Commands of the SENSe system

Command	Parameter	Unit	Remark
[SENSe[1..4]]			
:AVERage			
[:STATe][?]	ON|OFF		
:COUNt[?]	<int_value>	-	
:AUTO[?]	ON|OFF|ONCE		
:MTIMe[?]	<float_value>	S	
:RESolution[?]	1|2|3|4		
:SLOT	<int_value>	-	
:NSRatio[?]	<float_value>	DB|PCT	
:TYPE[?]	RESolution|NSR		
:TCONtrol[?]	MOVing|REPeat		
:CORRection			
:OFFSet[?]	<float_value>	DB|PCT	
:STATe[?]	ON|OFF		
:DCYCle			
[:INPut][:MAGNitude][?]	<float_value>	PCT	
:STATe[?]	ON|OFF		
:FDOFfset			
[:INPut][:MAGNitude]?	-	DB	
:FDOTable			
[:SELect][?]	<string>		
:STATe[?]	ON|OFF		
:SPDevice:STATe[?]	ON|OFF		
:FREQuency[:CW|:FIXed][?]	<float_value>	HZ	
:FUNCtion[:ON][?]	<sensor_function>		
[:POWer]			
[:AVG]			
:APERture[?]	<float_value>	S	
:BUFFer:SIZE[?]	<int_value>	-	
:BUFFer:STATe[?]	ON|OFF		
:RANGe[?]	0|1|2		
:AUTO[?]	ON|OFF		
:AUTO:CLEVel[?]	<float_value>	DB|PCT	
:SMOothing:STATe[?]	ON|OFF		
:TSLot[:AVG]			
:COUNt[?]	<int_value>	-	
:WIDTh[?]	<float_value>	S	
:BURSt[:AVG]			
:DTOLerance[?]	<float_value>	S	
:SAMPLing	FREQ1|FREQ2		
:SGAMma			
[:MAGNitude][?]	<float_value>	-	
:PHASe[?]	<float_value>	-	
:CORRection:STATe[?]	ON|OFF		

Command	Parameter	Unit	Remark
:SWEep			
:AVERage			
[:STATe][?]	ON|OFF		
:COUNt[?]	<int_value>	-	
:AUTO[?]	ON|OFF|ONCE		
:MTIMe[?]	<float_value>	S	
:RESolution[?]	1|2|3|4		
:SLOT	<int_value>	-	
:NSRatio[?]	<float_value>	DB|PCT	
:TYPE[?]	RESolution|NSR		
:TCONtrol[?]	MOVing|REPeat		
:OFFSet:TIME[?]	<float_value>	S	
:POINts[?]	<int_value>	-	
:REALtime[?]	ON|OFF		
:TIME[?]	<float_value>	S	
:TIMing:EXCLude			
:STARt[?]	<float_value>	S	
:STOP[?]	<float_value>	S	

[SENSe[1..4]]:AVERage[:STATe][?] ON | OFF

This command switches the filter function of a sensor on or off. When the filter is switched on, the number of measured values set with [SENSe[1..4]]:AVERage:COUNt is averaged. This reduces the effect of noise so that more reliable results are obtained.

***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt[?] <int_value>

This command sets the filter bandwidth. The wider the filter the lower the noise and the longer it takes to obtain a measured value.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt[?]:AUTO[?] ON | OFF | ONCE

This command can be used to automatically determine a value for [SENSe[1..4]]:AVERage:COUNt. If the command is called with the parameter ONCE, automatic switchover is deactivated (setting OFF) and the suitable filter length will then be defined and set automatically. The setting can then be queried via SENS[1..4]:AVER:COUN?. If the automatic switchover is activated with the ON parameter, the sensor always defines a suitable filter length which can also be queried via SENS[1..4]:AVER:COUN?.

***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt:AUTO:MTIMe[?] <float_value>

If the R&S NRP has to determine the filter length automatically, the filter length can become large and thus also the the time to fill the filter.

An upper time limit can be set via SENS[1..4]:AVER:COUN:AUTO:MTIME (maximum time). It should never be exceeded. Undesired long measurement times can thus be prevented if the automatic filter length switchover is on.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt:AUTO:RESolution[?] 1 | 2 | 3 | 4

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. This setting is also performed by the DISP[1..4]:RES command (→ page 6.30) that tries to set the sensors involved in the measurement results accordingly.

However, SENS[1..4]:AVER:COUN:AUTO:RES does not affect the DISPlay command. The parameters of the two commands are different but have the same meaning.

SENS[1..4]:AVER:COUN:AUTO:RES	1	2	3	4
DISP[1..4]:RES	1	0.1	0.01	0.001

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt:AUTO:SLOT[?] <int_value>

Sets a timeslot whose measured value is used to automatically determine the filter length.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt:AUTO:NSRatio[?] <float_value>

Indicates the maximum noise ratio in the measurement result.Achieving the same result by filter length setting is attempted only if
SENS[1..4]:AVER:COUN:AUTO ON and SENS[1..4]:AVER:COUN:AUTO:TYPE NSR are set.

Unit: DB | PCT
Default unit: DB
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSR

Selects a method by which the automatic filter length switchover can operate:

SENS[1..4]:AVER:COUN:AUTO:TYPE	Setting taken into account
RESolution	SENS[1..4]:AVER:COUN:AUTO:RES
NSR	SENS[1..4]:AVER:COUN:AUTO:NSR

***RST value:** depending on sensor

[SENSe[1..4]]:AVERage:TCONtrol[?] MOVing | REPeat

As soon as a new single value is determined, the filter window is advanced by one value so that the new value is taken into account by the filter and the oldest value is forgotten. [SENSe[1..4]]:AVERage:TCONtrol (terminal control) then determines whether a new result is calculated immediately after a new measured value is available (MOVing) or only after an entire range of new values is available for the filter (REPeat).

***RST value:** in manual control: MOV
in remote control: REP

[SENSe[1..4]]:CORRection:OFFSet[?] <float_value>

With this command a fixed offset value can be defined for multiplying (logarithmically adding) the measured value of a sensor. If the parameters are specified without a unit, the unit set by UNIT:POW:RAT will be used.

Unit: DB | PCT
Default unit: DB
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:CORRection:OFFSet[?]:STATe ON | OFF

This command switches the offset correction on or off.

***RST value:** depending on sensor

[SENSe[1..4]]:CORRection:DCYCle[:INPut][:MAGNitude][?] <float_value>

This command informs the R&S NRP about the duty cycle of the power to be measured. Specifying a duty cycle only makes sense in the ContAv mode where measurements are performed continuously without taking the timing of the signal into account. For this reason, this setting can only be chosen in the local mode when the sensor performs measurements in the ContAv mode.

Unit: PCT
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:CORRection:DCYCle:STATe[?] ON | OFF

This command switches measured-value correction for a specific duty cycle on or off.

***RST value:** depending on sensor

[SENSe[1..4]]:CORRection:FDOFfset[:INPut][:MAGNitude]? <float_value>

This command is a query only. The frequency-dependent measured-value correction is set by selecting a table with the [SENSe[1..4]]:CORRection:FDOTable[:SELect] and [SENSe[1..4]]:CORRection:FDOTable:STATe ON commands. The respective frequency-dependent correction factor is determined by means of the active tables (if necessary by interpolation) and can be queried with [SENSe[1..4]]:CORRection:FDOFfset[:INPut][:MAGNitude]? (frequency-dependent offset).

Unit: DB
***RST value:** none

[SENSe[1..4]]:CORRection:FDOTable[:SELect][?] <string>

The name of the current frequency-dependent offset table can be set or queried by the [SENSe[1..4]]:CORRection:FDOTable[:SELect][?] command. The R&S NRP can manage up to ten such tables (MEMory commands). The frequency-dependent offset tables consist of two columns; the first containing the frequencies, the second the associated correction values. When the R&S NRP is informed about the signal frequency with command [SENSe[1..4]]:FREQuency[:CW|:FIXed] <float_value>, an appropriate correction factor is determined by means of the table. If the table was activated with [SENSe[1..4]]:CORRection:FDOTable:STATe[?] ON , the measurement result obtained by the sensor is multiplied by this factor.

***RST value:** Settings are not changed in case of *RST.

Error messages:

-256 "**File name not found**": A table named <name> is not known.

[SENSe[1..4]]:CORRection:FDOTable:STATe[?] ON | OFF

This command activates and deactivates the current frequency-dependent offset table. The current table is selected with the [SENSe[1..4]]:CORRection:FDOTable[:SELect] command. Only one table can be active at a time.

***RST value:** OFF

[SENSe[1..4]]:CORRection:SPDevice:STATe[?] ON | OFF

Instructs the sensor to perform a measured-value correction by means of the stored s-parameter device.

***RST value:** depending on sensor

[SENSe[1..4]]:FREQuency[:CW|:FIXed][?] <float_value>

This command informs the R&S NRP about the frequency of the power to be measured since this frequency is not automatically determined. The frequency is used to determine a frequency-dependent correction factor for the measurement results.

Unit: HZ
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:FUNCtion[:ON][?] <sensor_function>

This command sets the sensor to one of the measurement modes of Table 6-9.

Table 6-9: Measurement modes

<sensor_function>	Designation of measurement mode
"POWer:AVG"	**ContAv** After a trigger event, the power is integrated over a time interval (Averaging) set with SENS:POW:APER.
"POWer:TSLot:AVG"	**Timeslot** The power is measured simultaneously in a number of timeslots (up to 26), which are set with SENS:POW:TSL:COUN. The length of a timeslot is set by SENS:POW:TSL:WIDT. The measurement result is represented by a vector that may contain up to 26 indexes, each containing the power of a timeslot.
"POWer:BURSt:AVG"	**Burst** In remote control, this measurement mode is very similar to the ContAv mode. A fixed integration time is not specified, however. SENS:POW:BURS:DTOL defines the time interval during which a signal drop below the trigger level is not interpreted as the end of the burst. In the BurstAv mode, the set trigger source is ignored.
"XTIMe:POWer"	A sequence of measurements is performed. The individual measured values are determined as in the ContAv mode. The length of an individual measurements is determined from the ratio of the total time (SENS:SWE:TIME) and the number of individual test points (SENS:SWE:POIN). In contrast to the Timeslot mode, where several single measurements are also performed in succession, each measurement has to be individually triggered in the Scope mode.

In the case of remote control, the timing (SENS:TIM:EXCL:STAR and -:STOP) and the trigger system of all measurement modes are user-selectable.

***RST value:** depending on sensor

Error messages:

24 "**Sensor mode not supported**": A sensor does not support a measurement mode.
28 "**Sensor not idle**": The sensor is not in the IDLE state.
-151 "**Invalid string data**": An invalid parameter was transmitted for <sensor_function>.

[SENSe[1..4]][:POWer][:AVG]:APERture[?] <float_value>

This command determines the integration time for a single measurement in the ContAv mode. To increase the measurement accuracy, this integration is followed by a second averaging procedure in a window with a selectable number of values. The filter window is configured with the [SENSe[1..4]]:AVERage commands.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:BUFFer:SIZE[?] <int_value>

Sets the number of desired values for the buffered ContAv mode.

Unit: -
Value range: 1..400000
***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:BUFFer:STATe[?] ON | OFF

Switches on the buffered ContAv mode, after which data blocks rather than single measured values are then returned. In this mode a higher data rate is achieved than in the non-buffered ContAv mode.
The number of desired measured values is set with the SENSe[1..4]:POWer:ARR:SIZE command.

***RST value:** depending on sensor

[SENSe[1..4]][:POWer]:TSLot:[AVG]:COUNt[?] <int_value>

Sets the number of simultaneously measured timeslots in the Timeslot mode.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]][:POWer]:TSLot:[AVG]:WIDTh[?] <float_value>

Sets the length of the timeslot in the Timeslot mode.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]][:POWer]:BURSt[:AVG]:DTOLerance[?] <float_value>

The end of a burst (power pulse) is recognized when the signal level drops below the trigger level. Especially with modulated signals, this may also happen for a short time within a burst. To prevent the supposed end of the burst is from being recognized too early or incorrectly at these positions, a time interval can be defined via SENS[1..4]:BURS:DTOL (drop-out tolerance) in which the pulse end is only recognized if the signal level no longer exceeds the trigger level. This is shown in Fig. 6-5: the drop-out time, i.e. the time in which the signal remains below the trigger level, is shorter than the drop-out tolerance. The burst end is thus recognized correctly.

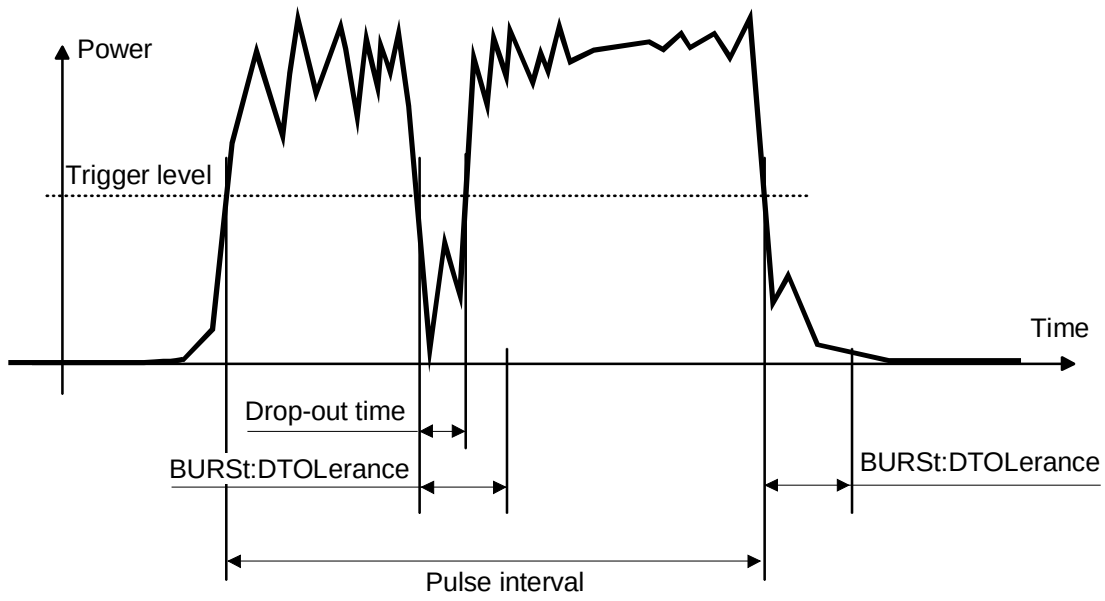

Fig. 6-5: Meaning of drop-out TOLerance.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:RANGe[?] 0 | 1 | 2

Selects a measurement range in which the corresponding sensor is to perform a measurement. This setting will only become effective if `SENS[1..4]:RANG:AUTO ON` is set.

***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:RANGe:AUTO[?] ON | OFF

Sets the automatic selection of a measurement range to ON or OFF.

***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:RANGe:AUTO:CLEVel[?] <float_value>

Sets the cross-over level. Shifts the transition ranges between the measurement ranges. This may improve the measurement accuracy for special signals, i.e. signals with a high crest factor.

Unit: DB | PCT
Default unit: DB
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]][:POWer][:AVG]:SMOothing:STATe[?] ON | OFF

Activates digital lowpass filtering of the sampled video signal.

The problem of instable display values due to a modulation of a test signal described under SENS[1..4]:SAMP can also be eliminated by lowpass filtering of the video signal. The lowpass filter eliminates the variations of the display even in case of unperiodic modulation and does not require any other setting.

If the modulation is periodic, the setting of the sampling window is the better method since it allows for shorter measurement times.

***RST value:** depending on sensor

[SENSe[1..4]]:SAMPling[?] FREQ1 | FREQ2

If the signal to be measured has modulation sections just above the video bandwidth of the sensor used, measurement errors might be caused due to aliasing effects. In this case, the sampling rate of the sensor can be set to a safe lower value (FREQ2). However, the measurement time required to obtain noise-free results is extended compared to the normal sampling rate (FREQ1).

***RST value:** depending on sensor

[SENSe[1..4]]:SGAMma[:MAGNitude][?] <float_value>

The R&S NRP can perform a measured-value correction taking the complex reflection coefficient (source gamma) of the signal source into account. SENS[1..4]:SGAM:CORR:STAT ON must be set. The magnitude of the reflection coefficient is set with SENS[1..4]:SGAM[:MAGN].

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SGAMma:PHASe[?] <float_value>

The R&S NRP can perform a measured-value correction taking the complex reflection coefficient (source gamma) of the signal source into account. SENS[1..4]:SGAM:CORR:STAT ON must be set. The phase angle of the reflection coefficient is set with SENS[1..4]:SGAM:PHAS.

Unit: - (Degree is assumed as unit)
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SGAMma:CORRection:STATe[?] ON | OFF

Switches the measured-value correction of the reflection coefficient effect of the source gamma ON or OFF.

***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage[:STATe][?] ON | OFF

For the Scope mode, this command switches the filter function of a sensor on or off. When the filter is switched on, the number of measured values set with [SENSe[1..4]]:AVERage:COUNt is averaged. This reduces the effect of noise so that more reliable results are obtained.

***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt[?] <int_value>

This command sets the length of the filter for the Scope mode. The wider the filter the lower the noise and the longer it takes to obtain a measured value.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt[?]:AUTO[?] ON | OFF | ONCE

This command can be used to automatically determine a value for [SENSe[1..4]]:AVERage:COUNt for the Scope mode. If the command is called with the parameter ONCE, automatic switchover is deactivated (setting OFF) and the suitable filter length will then be defined and set automatically. The setting can then be queried via SENS[1..4]:AVER:COUN?. If the automatic switchover is activated with the ON parameter, the sensor always defines a suitable filter length which can also be queried via SENS[1..4]:AVER:COUN?.

***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:MTIMe[?] <float_value>

If the R&S NRP has to determine the filter length automatically in the Scope mode, the filter length can become large and thus also the the time to fill the filter. An upper time limit (maximum time) can be set via SENS[1..4]:AVER:COUN:AUTO:MTIME. It should never be exceeded. Undesired long measurement times can thus be prevented if the automatic filter length switchover is on.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:RESolution[?] 1|2|3|4

Defines the number of significant places for the Scope mode for linear units and the number of decimal places for logarithmic units which should be free of noise in the measurement result. This setting is also performed by the DISP[1..4]:RES command (→ page 6.30) which tries to set the sensors involved in the measurement result accordingly. However, SENS[1..4]:AVER:COUN:AUTO:RES does not affect the DISPlay command. The parameters of the two commands are different but have the same meaning.

SENS[1..4]:AVER:COUN:AUTO:RES	1	2	3	4
DISP[1..4]:RES	1	0.1	0.01	0.001

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:POINt[?] <int_value>

Specifies the measured value in the Scope mode used for the automatic determination of the filter length.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:NSRatio[?] <float_value>

Indicates the maximum noise ratio in the measurement result for the Scope mode. Achieving the same result be filter length setting is attempted only if SENS[1..4]:AVER:COUN:AUTO ON and SENS[1..4]:AVER:COUN:AUTO:TYPE NSR are set.

Unit: DB | PCT
Default unit: DB
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSR

Selects a method for the Scope mode by which the automatic filter length switchover can operate:

SENS[1..4]:AVER:COUN:AUTO:TYPE	Setting taken into account
RESolution	SENS[1..4]:AVER:COUN:AUTO:RES
NSR	SENS[1..4]:AVER:COUN:AUTO:NSR

***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:AVERage:TCONtrol[?] MOVing | REPeat

As soon as a new single value is determined, the filter window is advanced by one value so that the new value is taken into account by the filter and the oldest value is forgotten. [SENSe[1..4]]:AVERage:TCONtrol (terminal control) then determines in the Scope mode whether a new result will be calculated immediately after a new measured value is available (MOVing) or only after an entire range of new values is available for the filter (REPeat).

***RST value:** in manual control: MOV
in remote control: REP

[SENSe[1..4]]:SWEep:OFFSet:TIME[?] <float_value>

This command determines the relative position of the trigger event in relation to the beginning of the Scope measurement sequence. The units are seconds in this case.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:POINts <int_value>

Sets the number of desired values per Scope sequence.

Unit: -
Value range: depending on sensor
***RST value:** depending on sensor

Error messages:

28 "**Sensor not idle**": The sensor is not in the IDLE state.

[SENSe[1..4]]:SWEep:REALtime[?] ON | OFF

In the default state (OFF), each measurement sequence from the sensor is averaged over several sequences. Since the measured values of a sequence may be closer to each other in time than the measurements, several measurement sequences with a slight time offset are also superimposed on the desired sequence. With `[SENSe[1..4]]:SWEep::REALtime ON` , this effect can be switched off, which may increase the measurement speed. This ensures that the measured values of an individual sequence are immediately delivered.

***RST value:** depending on sensor

[SENSe[1..4]]:SWEep:TIME[?] <float_value>

Sets the time to be covered by the Scope sequence.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:TIMing:EXCLude:STARt[?] <float_value>

Sets a time that is to be excluded at the beginning of the integration (→ Fig. 6-6).

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

[SENSe[1..4]]:TIMing:EXCLude:STOP[?] <float_value>

Sets a time that is to be excluded at the beginning of the integration (→ Fig. 6-6).

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

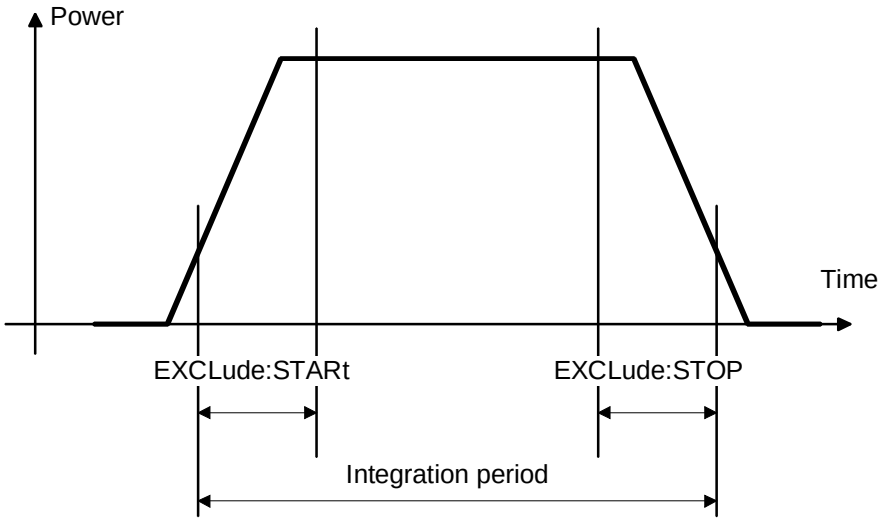

Fig. 6-6: Effect of commands `SENS[1..4]:TIM:EXCL:STAR` and `:STOP`

STATus

The status registers of the R&S NRP can be read and configured with commands of the STATus system. The R&S NRP uses the following status registers:

- Standard Event Status Register (specified in IEEE 488.2. Reading and configuring with *ESR? and *ESE. This register is not handled by the STATus system.)
- Device Status Register
- Questionable Status Register
- Questionable Power Status Register
- Questionable Window Status Register
- Questionable Calibration Status Register
- Operation Status Register
- Operation Calibrating Status Register
- Operation Measuring Status Register
- Operation Trigger Status Register
- Operation Sense Status Register
- Operation Lower Limit Fail Status Register
- Operation Upper Limit Fail Status Register

Except for the Standard Event Status Register, each of these registers comprises five subregisters with which the function of the register can be configured. These subregisters are called

- EVENt
- CONDition
- NTRansition
- PTRansition
- ENABle

The registers are 16 bits wide but only the lower 15 bits are used. This prevents problems with programs that cannot handle integers without sign.

For the sake of conciseness, not all commands are listed here. For a complete →List of Remote Control Commands see page 6.92. The STATus system uses the following types of commands:

Queries return a decimal value between 0 and 32767 ($=2^{15}-1$).

Configuration commands set the ENABle, PTRansition, NTRansition registers of a status register and thus determine the response of the register to status changes in the R&S NRP.

Queries

Table 6-10: Queries for status registers

Command	Status register
STATus	
:DEVice	Device Status
:OPERation	Operation Status
:CALibrating[:SUMMary]	Operation Calibrating
:LLFail[:SUMMary]	Operation Lower Limit Fail
:ULFail[:SUMMary]	Operation Upper Limit Fail
:MEASuring[:SUMMary]	Operation Measuring
:SENSe[:SUMMary]	Operation Sense
:TRIGger[:SUMMary]	Operation Trigger
:QUEStionable	Questionable Status
:CALibration[:SUMMary]	Questionable Calibration
:POWer[:SUMMary]	Questionable Power
:WINDow[:SUMMary]	Questionable Window

Configuration Commands

If the status register queries are extended by the character strings `[:EVENt]`, `:CONDition`, `:ENABle`, `:PTRansition` or `NTRansition`, the respective subregisters can be accessed. The enable and transition registers can also be set with these commands. The effect of the status reporting system can thus be adapted to user requirements. The parameters have the following meaning:

<status_register_summary_command> One of the status register queries from Table 6-10 is to be used here.

<NR1> Is a decimal value between 0 and 32767. The values `DEFAULT`, `MINIMUM` and `MAXIMUM` are not permissible.

<non-decimal numeric> Is a non-decimal value in one of the following formats, where the decimal value must be between 0 and 32767:

- binary (e. g. `#b0111010101001110` or `#B0111010101001110`)
- hexadecimal (e.g. `#h754e` or `#H754E`)
- octal (e.g. `#q72516` or `#Q75216`)

Table 6-11: Commands for the configuration of status registers

Command	Parameter	Remark
<status_register_summary_command>		
[:EVENt]?		Query only
:CONDition?		Query only
:ENABle[?]	0..32767 | <non-decimal numeric>	
:NTRansition[?]	0..32767 | <non-decimal numeric>	
:PTRansition[?]	0..32767 | <non-decimal numeric>	
STATus:PRESet		

The status reporting system stores all information about the current operating status of the device and errors that occur. The information is stored in the status registers and the error queue. The contents of the status registers and error queue can be queried via the IEC/IEEE bus. The information is hierarchically structured. The highest level is formed by the Status Byte Register (STB) defined by IEEE 488.2 and the associated Service Request Enable (SRE) register. The STB receives its information from the Standard Event Status Register (ESR) also defined by IEEE 488.2 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.

The status reporting system also includes the IST flag (Individual STatus) and the Parallel Poll Enable Register (PPE) assigned to it. The IST flag, like the SRQ, combines the complete device status in a single bit. The PPE has the same function for the IST flag as the SRE has for the service request.

The output buffer (output queue) contains the messages the device returns to the controller. It is not part of the status reporting system but since it determines the value of the MAV bit in the STB it is also shown in Fig. 6-8.

Structure of SCPI Status Register

Each SCPI register consists of five 16-bit registers which have different functions (→ Fig. 6-7). 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. For instance, bit 4 of the operation status register is assigned to the hardware status "Measurement" in 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.

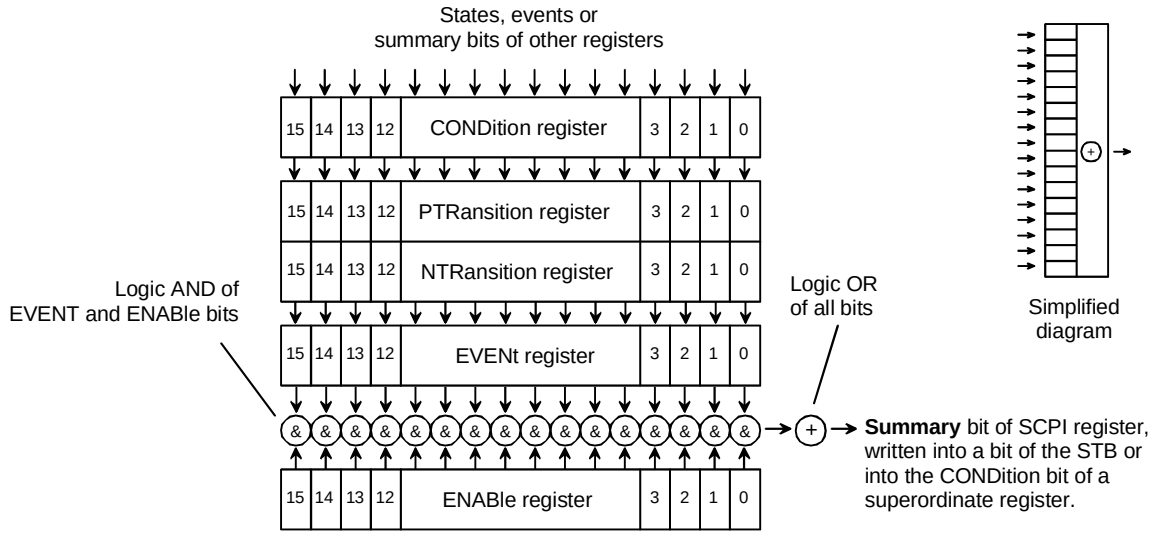

Fig. 6-7: Standard SCPI status register

Table 6-12: Decimal value of individual bits in the SCPI status register

Bit No.	Decimal value	Bit No.	Decimal value	Bit No.	Decimal value	Bit No.	Decimal value
0	1	4	16	8	256	12	4096
1	2	5	32	9	512	13	8192
2	4	6	64	10	1024	14	16384
3	8	7	128	11	2048	15	32768

CONDition register

The CONDition register is directly written by the hardware or the summary bit of the next lower register. Its content reflects the current device status.

This register can only be read; it cannot be written to or cleared. Reading the register does not change its contents.

PTRansition register

The Positive TRansition register acts as a transition filter. When a bit of the CONDition register changes from 0 to 1, the associated PTR bit determines whether the EVENt bit will be set to 1.

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

This register can be written to and read. Reading the register does not change its contents.

NTRansition register

The Negative TRansition register also acts as a transition filter. Upon transition of a bit of the CONDition register from 1 to 0, the associated NTR bit determines 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 register can be written to and read. Reading the register does not change its contents.
With the aid of these two transition filter registers the user can define the status change of the CONDition register (none, 0 to 1, 1 to 0 or both) that is to be recorded in the EVENt register.

EVENt register

The EVENt register reports whether an event has occurred since its last reading; it is the "memory" of the CONDition register. It only registers events that have been reported by the transition filters. The EVENt register is continuously updated by the device.

It can only be read by the user. Reading this register clears its contents.

This register is frequently referred to as the overall register.

ENABle register The ENABle register determines whether the associated EVENt bit influences the summary bit (see below). Each bit of the EVENt register is ANDed (symbol '&') with the associated ENABle bit. The events of all logical operations of this register are ORed (symbol '+') and passed on to the summary bit.

ENABle bit = 0: the associated EVENt bit does not affect the summary bit. bit = 1: if the associated EVENT bit is "1", the summary bit is also set to "1".

This register can be written to and read as required. Reading the register does not change its contents.

Summary bit As stated above, the summary bit for each register is derived from the EVENt and ENABle registers. The result is entered into a bit of the CONDition register of the next higher register. The device automatically generates the summary bit for each register. An event may thus cause a service request through all hierarchical levels.

Note: *The Service Request Enable register (SRE) defined by IEEE488.2 can be viewed as the ENABle register of the STB. Accordingly, the ESE can be viewed as the ENABle register of the ESR.*

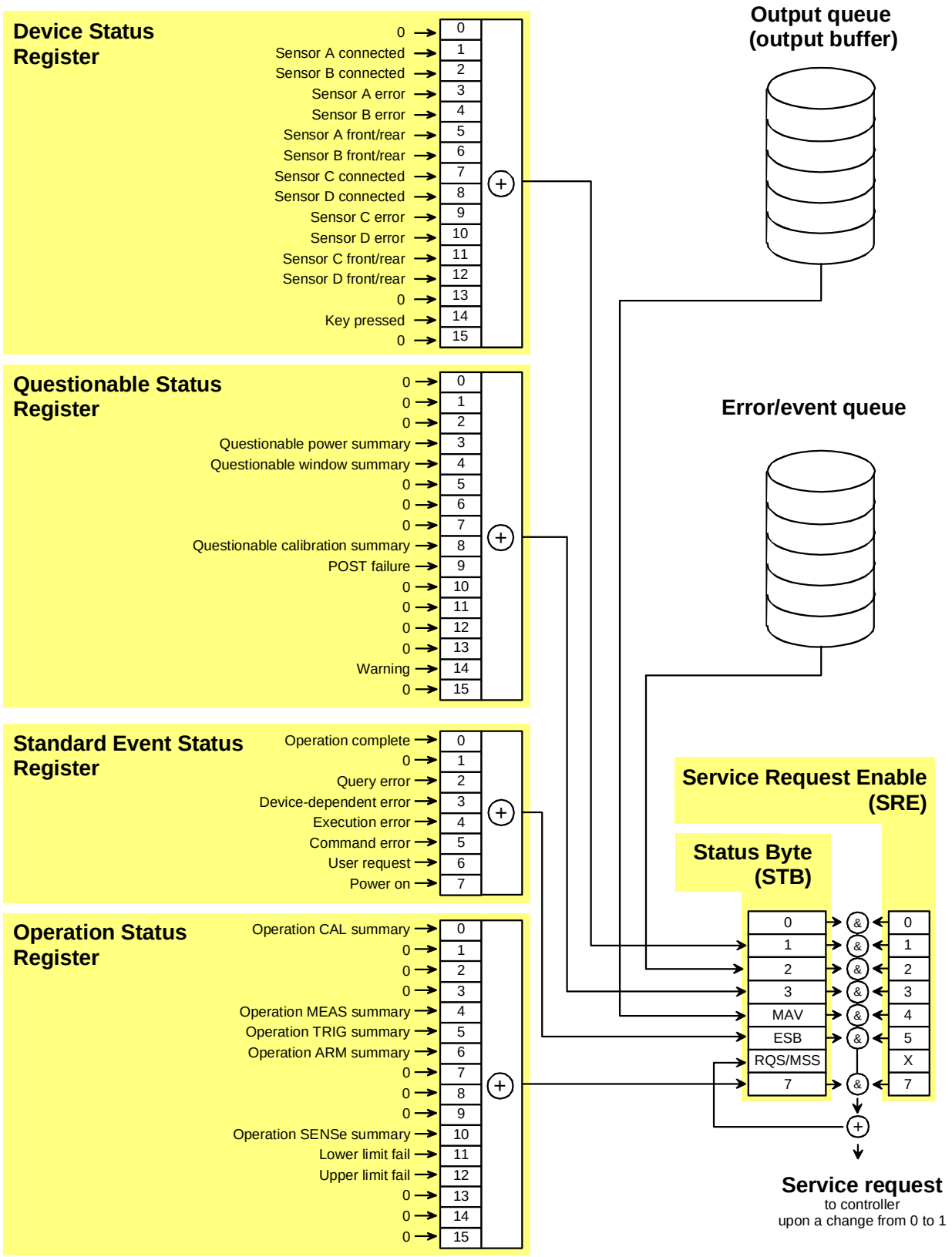

Fig. 6-8: Overview on structure of Status Reporting System

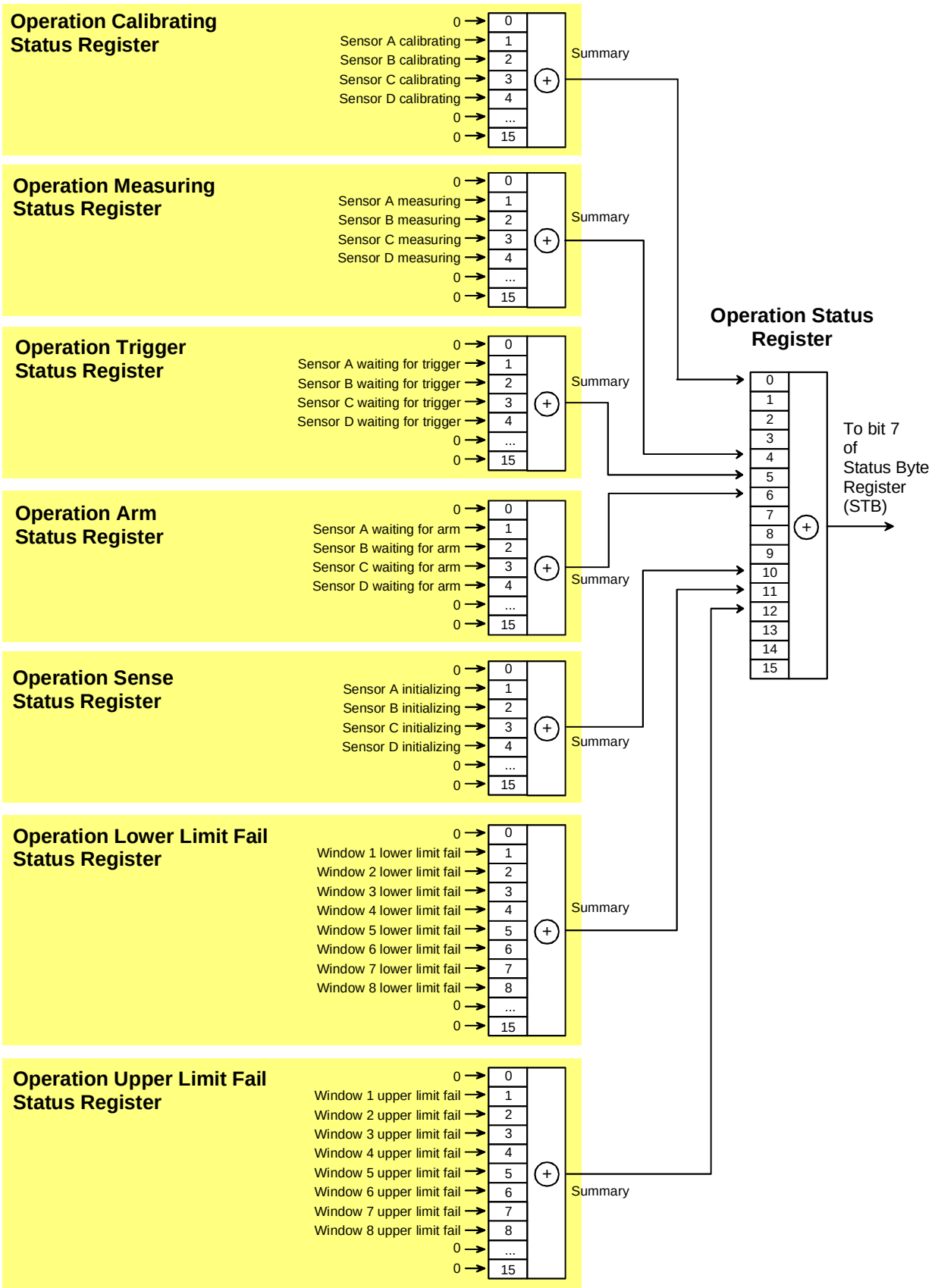

Fig. 6-9: Operation Status Register

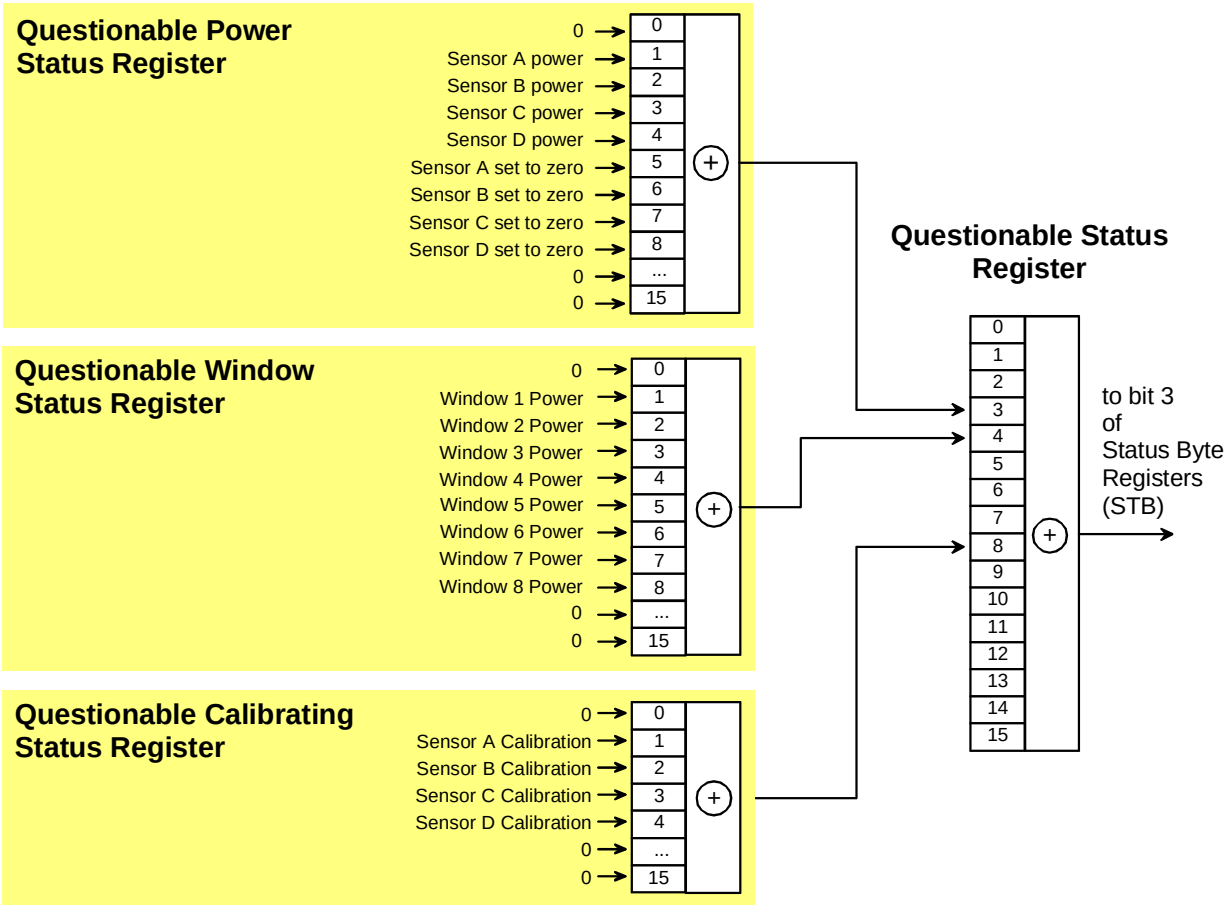

Fig. 6-10: Questionable Status Register

Description of Status Registers

In the following sections the SCPI status registers shown in Fig. 6-8 to Fig. 6-10 are described in detail:

- Status Byte (STB)
- Service Request Enable Register (SRE)
- Device Status Register
- Questionable Status Register
- Standard Event Status Register (ESR) with ENABle register (ESE)
- Operation Status Register
- Operation Calibrating Status Register
- Operation Measuring Status Register
- Operation Trigger Status Register
- Operation Sense Status Register
- Operation Lower Limit Fail Status Register
- Operation Upper Limit Fail Status Register
- Questionable Power Status Register
- Questionable Window Status Register
- Questionable Calibration Status Register

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 device 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 6-13: 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 this register, this bit is set when a sensor is connected or disconnected, when an error has occurred in a sensor or when a key has been pressed.
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 device 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 device 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 device. Information on the type of action can be obtained by querying the Operation Status Register.

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 (→ section Parallel Poll, page 6.74) 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.

Device Status Register

This register contains information on current device states (CONDition register) or states that occurred since the last query (EVENt register).

The register can be read by the queries `STATus:DEVice:CONDition?` or `STATus:DEVice[:EVENt]?`.

Table 6-14: Meaning of bits used in the Device Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A connected**
2	**Sensor B connected**
3	**Sensor A error** Sensor A is erroneous.
4	**Sensor B error** Sensor B is erroneous.
5	**Sensor A Front/Rear** Indicates whether sensor A is connected at the front (bit is not set) or rear (bit is set) of the device.
6	**Sensor B Front/Rear** Indicates whether sensor B is connected at the front (bit is not set) or rear (bit is set) of the device.
7	**Sensor C connected**
8	**Sensor D connected**
9	**Sensor C error** Sensor C is erroneous.
10	**Sensor D error** Sensor D is erroneous.
11	**Sensor C Front/Rear** Indicates whether sensor C is connected at the front (bit is not set) or rear (bit is set) of the device.

Bit No.	Meaning
12	**Sensor D Front/Rear** Indicates whether sensor D is connected at the front (bit is not set) or rear (bit is set) of the device.
13	Not used
14	**Key pressed** This bit is always set if a key on the front panel is pressed (CONDition) or was pressed (EVENt).
15	Bit 15 will never be used.

Questionable Status Register

This register contains information on questionable device states. Such states may occur when the device is not operated in compliance with its specifications. The register can be read by the queries `STATus:QUEStionable:CONDition?` or `STATus:QUEStionable[:EVENt]?`.

Table 6-15: 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	**Questionable Window Status Register summary bit** Corresponds to the summary bit of the Questionable Windows Status Register.
5 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 NRP carried out automatically upon power-up has generated an error.
10 to 13	Not used
14	**Warning**
15	Bit 15 will never be used.

Standard Event Status Register (ESR)
Standard Event Status Enable Register (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 by the command *ESE and read out by the query *ESE?.

Table 6-16: 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
2	**Query Error** This bit is set in either of the two following cases: the controller wants to read data from the device but has not sent a query, or it sends new commands to the device 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 device-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 upon pressing the [LOCAL] key, i.e. when the device is switched to manual control.
7	**Power On** This bit is set when the device is switched on.

Operation Status Register

The CONDition register contains information on the operations currently being performed by the device, while the EVENt register contains information on the operations performed by the device since the last readout of the register.
These two registers can be read by the queries `STATus:OPERation:CONDition?` or `STATus:OPERation[:EVENt]?`.

Table 6-17: Meaning of bits used in the Operation Status Register

Bit No.	Meaning
0	**Operation Calibrating Status Register summary bit** This bit is set if one of the sensors is being calibrated.
1 to 3	Not used
4	**Operation Measuring Status Register summary bit** This bit is set if one of the sensors is performing a measurement.
5	**Operation Trigger Status Register summary bit** This bit is set if a sensor is in the WAIT_FOR_TRG state, i.e. waiting for a trigger event.
6	Not used
7 to 9	Not used
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.

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 Operation Calibration Status Register can be read by the following commands:
`STATus:OPERation:CALibrating[:SUMMary]:CONDition?`
`STATus:OPERation:CALibrating[:SUMMary][:EVENt]?` .

Table 6-18: Meaning of bits used in the Operation Calibrating Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A is being calibrated**
2	**Sensor B is being calibrated**
3	**Sensor C is being calibrated**
4	**Sensor D is being calibrated**
5 to 14	Not used
15	Bit 15 will never be used.

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 Operation Measuring Status Register can be read by the following commands:
`STATus:OPERation:MEASuring[:SUMMary]:CONDition?`
`STATus:OPERation:MEASuring[:SUMMary][:EVENt]?`.

Table 6-19: Meaning of bits used in the Operation Measuring Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A measuring** Sensor A is performing a measurement.
2	**Sensor B measuring** Sensor B is performing a measurement.
3	**Sensor C measuring** Sensor C is performing a measurement.
4	**Sensor D measuring** Sensor D is performing a measurement.
5 to14	Not used
15	Bit 15 will never be used.

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 Operation Trigger Status Register can be read by the following commands:
`STATus:OPERation:TRIGger[:SUMMary]:CONDition?`
`STATus:OPERation:TRIGger[:SUMMary][:EVENt]?` .

Table 6-20: Meaning of bits used in the Operation Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A waiting for trigger** Sensor A is in the WAIT_FOR_TRG state and is waiting for a trigger event that will change it to the MEASURING state.
2	**Sensor B waiting for trigger** Sensor B is in the WAIT_FOR_TRG state and is waiting for a trigger event that will change it to the MEASURING state.
3	**Sensor C waiting for trigger** Sensor C is in the WAIT_FOR_TRG state and is waiting for a trigger event that will change it to the MEASURING state.
4	**Sensor D waiting for trigger** Sensor D is in the WAIT_FOR_TRG state and is waiting for a trigger event that will change it to the MEASURING state.
5 to 14	Not used
15	Bit 15 will never be used.

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 Operation Sense Status Register can be read by the following commands:
`STATus:OPERation:SENSe[:SUMMary]:CONDition?`
`STATus:OPERation:SENSe[:SUMMary][:EVENt]?`

Table 6-21: Meaning of bits used in the Operation Sense Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A initializing** Sensor A is being initialized.
2	**Sensor B initializing** Sensor B is being initialized.
3	**Sensor C initializing** Sensor C is being initialized.
4	**Sensor D initializing** Sensor D is being initialized.
5 to 14	Not used
15	Bit 15 will never be used.

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 behaviour are defined by the transition register.

The limit value can be set with the command `CALC:LIM:LOW:DATA <float_value>` . Command `CALC:LIM:LOW:STAT ON` configures the PTRansition and NTRansition registers so that the corresponding bit is set in the EVENt register when the displayed value drops below the limit.

The Operation Lower Limit Fail Status Register can be read by the following commands:
`STATus:OPERation:LLIMit[:SUMMary]:CONDition?`
`STATus:OPERation:LLIMit[:SUMMary][:EVENt]?`

Table 6-22: Meaning of bits used in the Operation Lower Limit Fail Status Register

Bit No.	Meaning
0	Not used
1	**Window 1 Lower Limit Fail** The measured value returned by the first Calculate block drops below the lower limit value.
2	**Window 2 Lower Limit Fail** The measured value returned by the second Calculate block drops below the lower limit value.
3	**Window 3 Lower Limit Fail** The measured value returned by the third Calculate block drops below the lower limit value.
4	**Window 4 Lower Limit Fail** The measured value returned by the fourth Calculate block drops below the lower limit value.
5	**Window 5 Lower Limit Fail** The measured value returned by the fifth Calculate block drops below the lower limit value.
6	**Window 6 Lower Limit Fail** The measured value returned by the sixth Calculate block drops below the lower limit value.
7	**Window 7 Lower Limit Fail** The measured value returned by the seventh Calculate block drops below the lower limit value.
8	**Window 8 Lower Limit Fail** The measured value returned by the eighth Calculate block drops below the lower limit value.
9 to 14	Not used
15	Bit 15 will never be used.

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. Details of the behaviour are defined by the transition register. The limit value can be set with the command `CALC:LIM:UPP:DATA <float_value>` . Command `CALC:LIM:UPP:STAT ON` configures the PTRansition and NTRansition registers so that the corresponding bit is set in the EVENt register when the displayed value exceeds the upper limit value.

The Operation Upper Limit Fail Status Register can be read by the commands `STATus:OPERation:ULIMit[:SUMMary]:CONDition?` and `STATus:OPERation:ULIMit[:SUMMary][:EVENt]?` .

Table 6-23: Meaning of bits used in the Operation Upper Limit Fail Status Register

Bit No.	Meaning
0	Not used
1	**Window 1 Upper Limit Fail** The measured value returned by the first Calculate block exceeds the upper limit value.
2	**Window 2 Upper Limit Fail** The measured value returned by the second Calculate block exceeds the upper limit value.
3	**Window 3 Upper Limit Fail** The measured value returned by the third Calculate block exceeds the upper limit value.
4	**Window 4 Upper Limit Fail** The measured value returned by the fourth Calculate block exceeds the upper limit value.
5	**Window 5 Upper Limit Fail** The measured value returned by the fifth Calculate block exceeds the upper limit value.
6	**Window 6 Upper Limit Fail** The measured value supplied by the sixth Calculate block exceeds the upper limit value.
7	**Window 7 Upper Limit Fail** The measured value supplied by the seventh Calculate block exceeds the upper limit value.
8	**Window 8 Upper Limit Fail** The measured value supplied by the eighth Calculate block exceeds the upper limit value.
9 to14	Not used
15	Bit 15 will never be used.

Questionable Power Status Register

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

The Questionable Power Status Register can be read by the following commands:
`STATus:QUEStionable:POWer[:SUMMary]:CONDition?`
`STATus:QUEStionable:POWer[:SUMMary][:EVENt]?`

Table 6-24: Meaning of bits used in the Questionable Power Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A Power** The measurement data of sensor A is corrupt.
2	**Sensor B Power** The measurement data of sensor B is corrupt.
3	**Sensor C Power** The measurement data of sensor C is corrupt.
4	**Sensor D Power** The measurement data of sensor D is corrupt.
5	**Sensor A please zero** The zero correction for sensor A is no longer correct and should be repeated.
6	**Sensor B please zero** The zero correction for sensor B is no longer correct and should be repeated.
7	**Sensor C please zero** The zero correction for sensor C is no longer correct and should be repeated.
8	**Sensor D please zero** The zero correction for sensor D is no longer correct and should be repeated.
9 to 14	Not used
15	Bit 15 will never be used.

The sensor power bit is set when error -230, "Data corrupt or stale", or -231, "Data questionable", occurs in the respective sensor.

Questionable Window Status Register

The CONDition register contains information as to whether the displayed data or the power calculated by the calculate blocks is questionable.

The Questionable Window Status Register can be read by the following commands:
`STATus:QUEStionable:WINDow[:SUMMary]:CONDition?`
`STATus:QUEStionable:WINDow[:SUMMary][:EVENt]?`

Table 6-25: Meaning of bits used in the Questionable Window Status Register

Bit No.	Meaning
0	Not used
1	**Window 1 Power** The measured values returned by Calculate block 1 are corrupt.
2	**Window 2 Power** The measured values returned by Calculate block 2 are corrupt.
3	**Window 3 Power** The measured values returned by Calculate block 3 are corrupt.
4	**Window 4 Power** The measured values returned by Calculate block 4 are corrupt.
5	**Window 5 Power** The measured values returned by Calculate block 5 are corrupt.
6	**Window 6 Power** The measured values returned by Calculate block 6 are corrupt.
7	**Window 7 Power** The measured values returned by Calculate block 7 are corrupt.
8	**Window 8 Power** The measured values returned by Calculate block 8 are corrupt.
9 to 14	Not used
15	Bit 15 will never be used.

A bit is set if the error -231, "Data questionable", occurs in the respective calculate block.

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 Questionable Calibration Status Register can be read by the following commands:
`STATus:QUEStionable:CALibration[:SUMMary]:CONDition?`
and`STATus:QUEStionable:CALibration[:SUMMary][:EVENt]?`

Any information about an invalid calibration is irrelevant since the sensors of the R&S NRP are factory-calibrated.

Table 6-26 Meaning of bits used in the Questionable Calibration Status Register

Bit No.	Meaning
0	Not used
1	**Sensor A Calibration** Calibration of sensor A is invalid.
2	**Sensor B Calibration** Calibration of sensor B is invalid.
3	**Sensor C Calibration** Calibration of sensor C is invalid.
4	**Sensor D Calibration** Calibration of sensor D is invalid.
5 to 14	Not used
15	Bit 15 will never be used.

Use of Status Reporting System

For an efficient use of the status reporting system, the information it contains has to be transferred to the controller and further processed. There are various methods which are described in the following.

Service Request, Use of the Hierarchical Structure

Under certain conditions, the device may send a service request (SRQ) to the controller. This service request usually causes an interrupt at the controller to which the controller program can respond by suitable actions. As shown in Fig. 6-8, an SRQ will always be triggered if one or several of the bits 2, 3, 4, 5 or 7 have been set in the Status Byte Register and enabled in the SRE. Each of these bits combines the information from another register, from the error queue or the output buffer. If the ENABle registers of the status registers are set accordingly, any bit in any status register will be able to trigger an SRQ. To utilize the possibilities of the service request, all bits in the enable registers SRE and ESE should be set to "1".

Examples (see also Fig. 6-8):

Use the `*OPC` command to generate an SRQ:

- Set bit 0 (operation complete) in the ESE.
- Set bit 5 (ESB) in the SRE.
- The device generates an SRQ upon completion of its settings.

Informing the controller by an SRQ that a measurement has been completed:

- Set bit 7 (summary bit of Status Operation Register) in the SRE.
- Set bit 4 (measuring) in the ENABle register of the Status Operation Register.
- Set bit 4 in the NTRansition register of the Status Operation Register to ensure that the transition of measuring bit 4 from 1 to 0 (end of measurement) is also recorded in the EVENt register.
- The device generates an SRQ when the measurement is completed.

The SRQ is the only way for the device to become active of its own. Each controller program should set the device such that a service request is triggered in case of malfunctions. The program should respond accordingly to the service request.

Serial Poll

Like the `*STB?` command, the serial poll is used to query the status byte of a device. Querying is implemented by interface messages, however, and is therefore much quicker. The serial poll method has already been defined in the IEEE 488.1 standard, and used to be the only standard method of querying the Status Byte Register. This method also works with devices that conform neither to SCPI nor to IEEE 488.2. Serial poll is mainly used to obtain a quick overview of the device status of several devices connected to the IEC/IEEE bus.

Parallel Poll

In case of a parallel poll, up to eight devices are simultaneously requested by the controller to transmit one bit of information on the data line, i.e. to set the data line assigned to each device to logical 0 or 1. Analogously to the SRE register, which determines the conditions for generating an SRQ, a Parallel Poll Enable Register (PPE) is available which is ANDed bit-by-bit with the STB (taking into account bit 6). The results are ORed and the result is then sent (possibly in inverted format) to the controller as a response to a parallel poll. The result can also be read without a parallel poll by the query `*IST?`.

The parallel poll mode is mainly used to quickly find out which of the many devices connected to the IEC/IEEE bus caused an SRQ. For this purpose, SRE and PPE must be set to the same value.

Queries

Each part of a status register can be read out by queries. The queries are specified in the description of the SCPI commands (command system STATus). The queries always yield a number representing the bit pattern of the queried register. This number is evaluated by the controller program.

Queries are mainly used after an SRQ to obtain detailed information about the cause of the SRQ.

Error Queue Query

Each error in the device causes an entry in the error queue. The entries in the error queue are error messages in plain text. If a sensor is connected, sensor-specific errors can be seen via manual control in the menu File→Error List or in remote control via "Error List...". Usually, the error queue is read with the SCPI query `SYSTem:ERRor?`. Each `SYSTem:ERRor?` query is answered by an entry from the error queue. If there are no more error messages in the error queue, 0 = "No error" is returned by the device.

The error queue should be queried in the controller program after each SRQ since the queue entries provide a more precise description of the error cause than the status registers. In particular, in the test phase of a controller program the error queue should be queried at regular intervals since it also registers faulty commands from the controller to the device.

Initialization of the SCPI Status Registers

The commands *RST, *DCL and SYSTem:PRESet as well as powering on the device also affect the status reporting system. Table 6-27 contains the various commands and events causing a reset of the status reporting system. None of the commands, with the exception of *RST and SYSTem:PRESet, affects the functional device settings. In particular, DCL does not clear the device settings.

Table 6-27: Initialization of device status

Result / Effect	Power On		DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
	Power-On-Status Clear (*PSC)					
	0	1				
Clear STB (Status Byte) and ESR (Standard Event Status Register)	--	yes	--	--	--	yes
Clear SRE (Service Request Enable) and ESE (Standard Event Status Enable)	--	yes	--	--	--	--
Clear PPE (Parallel Poll Enable)	--	yes	--	--	--	--
Clear EVENt register	--	yes	--	--	--	yes
Clear ENABle register of all OPERation and QUEStionable registers	--	yes	--	--	yes	--
Fill PTRansition register with "1", delete NTRansition register	--	yes	--	--	yes	--
Clear error/event queue	yes	yes	--	--	--	yes
Clear output queue	yes	yes	yes	1)	1)	1)
Stop command processing (parser) and clear input queue	yes	yes	yes	--	--	--

1) Any command sent to a non-empty output queue causes the error -410, "Query interrupted".

SYSTem

With the aid of the SYSTem system, administrative device settings can be made and queried. This includes:

- password management
- list of error messages
- EC/IEEE-bus address
- resetting the NRP
- setting the date and time
- audible signals
- version numbers of hardware and software
- setting the system speed

Table 6-28: Commands of the SENSe system

Command	Parameter	Unit	Remark
SYSTem			
:BATTery			
:STATus?			Query only
:MODE	<block_data>		No query
:BEEPer			
[:IMMediate]	-		No query
:TIME	<NRf>	MS	No query
:COMMunicate			
:GPIB			
[:SELF]:ADDRess	0..30		No query
:DATE[?]	<year>,<month>,<day>		
:INFO?	[<string >]		Query only
:ERRor?	-		Query only
:KEY	<NR1> | character_value>		No query
:PRESet	-		No query
:SENSor[1..4]			
:INFO?	[<string >]		Query only
:RESet	-		No query
:SPEed	NORMal | FAST		No query
:TIME[?]	<hour>,<minute>,<second>		
:VERSion?	-		Query only

SYSTem:BATTery:MODE <block_data>

This command is used to send data to the SmartBattery if the option (R&S NRP-B3) has been installed. The data consists of 4 bytes (for a detailed definition see Service manual). The command always has the following format SYST:BATT:MODE #14*xxxx*.

Byte No.	Meaning
1	Number of battery
2	0x01: RemainingTimeAlarm 0x02: ChargerMode
3	Low data byte
4	High data byte

SYSTem:BATTery:STATus?

This command returns block data with 40 data bytes (#240.....) containing the current state of the SmartBattery if the option (R&S NRP-B3) has been installed. The data mainly contains data defined in the Smart Battery Data Specification (SBS).

Byte No.	Name	Description	SBS Code
1,2	Battery	Number of battery	
3,4	RemainingCapacityAlarm	Threshold for remaining capacity below which an alarm is triggered. Unit: mAh, if CAPACITY_MODE bit = 0 10 mWh, if CAPACITY_MODE bit = 1	0x01
5,6	BatteryMode	Battery modes, capabilities and flags (see SBS)	0x03
7,8	Temperature	Internal temperature of battery pack Unit: 0,1 K	0x08
9,10	Voltage	Current battery voltage Unit: mV	0x09
11,12	Current	Current charging or discharging current Unit: mA	0x0a
13,14	AverageCurrent	1-minute average of charging or discharging current Unit: mA	0x0b
15,16	RelativeStateOfCharge	Remaining battery capacity relative to FullChargeCapacity Unit: %	0x0d
17,18	RemainingCapacity	Remaining battery capacity Unit: mAh, if CAPACITY_MODE bit = 0 10 mWh, if CAPACITY_MODE bit = 1	0x0f
19,20	FullChargeCapacity	Expected battery capacity after full charging Unit: mAh, if CAPACITY_MODE bit = 0 10 mWh, if CAPACITY_MODE bit = 1	0x10

Byte No	Name	Description	SBS Code
21,22	RunTimeToEmpty	Expected remaining runtime of battery with current discharging rate Unit: min	0x11
23,24	AverageTimeToEmpty	Expected remaining runtime of battery with average discharging time of 1 min. Unit: min	0x12
25,26	AverageTimeToFull	Expected remaining charging time Unit: min	0x13
27,28	BatteryStatus	Comprises alarm and status bits (see SBS)	0x16
29,30	CycleCount	Number of discharging cycles of battery unit	0x17
31,32	DesignCapacity	Nominal battery capacity Unit: mAh, if CAPACITY_MODE bit = 0 10mWh, if CAPACITY_MODE bit = 1	0x18
33,34	DesignVoltage	Nominal battery voltage Unit: mV	0x19
35,36	SpecificationInfo	Supported version number of smart battery specification and scaling data (see SBS)	0x1a
37,38	ManufactureDate	Manufacturing date (see SBS)	0x1b
39,40	SerialNumber	Serial number of battery	0x1c

SYSTem:BEEPer[:IMMediate]

Generates an audible signal via the built-in loudspeaker. The duration of the signal is set with SYST:BEEP:TIME. Frequency and volume cannot be changed. The signal is only output if it is not switched off with SYS:BEEP:STAT OFF.

SYSTem:BEEPer:TIME <NRf>

Sets the length in milliseconds of the audible signal output with SYS:BEEP.

Value range: 1..2147483647
***RST value:** This setting is not changed by *RST.

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <NR1>

Sets the address with which the R&S NRP can be addressed via the IEC/IEEE bus. The address is factory-set to 20 and is not changed by a reset.

Value range: 0..30
***RST value:** This setting is not changed by *RST.

SYSTem:DATE[?] <year>,<month>,<day>

Parameter	Value range
<year>	2000 ... 2100
<month>	1 (January) ... 12 (December)
<day>	1 ... 31

Sets the date. Since the R&S NRP has no battery-backed clock, the date has to be reset each time a new measurement is started if the clock was not set after the last power-on of the R&S NRP. →SYSTem:TIME[?] <hour>,<minute>,<second>.

***RST value:** This setting is not changed by *RST.

SYSTem:INFO? [<string>]

Returns information about the system. <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. No difference is made between upper-case and lower-case letters:

<string_value>	Meaning
"Manufacturer"	Manufacturer of device
"Type"	Type (R&S NRP)
"Stock Number"	Order No. of R&S NRP
"Serial"	Serial number
"HWVersion"	Hardware version
"SW Build"	Firmware version
"BootloadVer"	Version of boot loader
"KeybCtrlVer"	Version of keyboard controller
"Options"	Installed options
"MACAddr"	MAC address of the R&S NRP if Ethernet option has been installed
"RAMSize"	RAM size
"ROMSize"	ROM size
"CPUClock"	Clock frequency of processor
"CPLDVersion"	Version of CPLD chip

<string_value>	Meaning
"PICVersion"	Version of PIC-Chip

SYSTem:ERRor?

This query returns error numbers and text from the error/event queue of the R&S NRP. A specific error number with text is entered in the error/event queue for each error that occurs in the NRP. The queue functions according to the FIFO principle. The message entered first in the queue is also output first when a SYST:ERR? query is sent. Querying clears the message.

Up to 30 errors can be stored in the error/event queue. If further errors occur, the most recent error is overwritten by the message -350, "Queue overflow".

If the error/event queue is empty, the message 0, "No error" is returned as a response.

The queue is cleared by *CLS. It is not changed by *RST.

For further information on the error/event queue see section →"STATus", page 5.1.

SYSTem:KEY <NR1> | <character_value>

This command is used for testing purposes only and simulates a single stroke of an R&S NRP front-panel key.

The key to be simulated is described either in plain text (<character_value>) or by a key code (<NR1>) (→ Table 6-29).

Table 6-29: Valid parameter values for the SYSTem:KEY command.

Simulated front-panel key	<character_value>	<NR1>
Softkey toggle 1 left	SK1L	1
Softkey toggle 1 right	SK1R	2
Softkey toggle 2 left	SK2L	3
Softkey toggle 2 right	SK2R	4
Softkey toggle 3 left	SK3L	5
Softkey toggle 3 right	SK3R	6
Softkey toggle 4 left	SK4L	7
Softkey toggle 4 right	SK4R	8
Softkey toggle 5 left	SK5L	9
Softkey toggle 5 right	SK5R	10

Simulated front-panel key	<character_value>	<NR1>
Softkey toggle 6 left	SK6L	11
Softkey toggle 6 right	SK6R	12
(PRE)SET	PRESet	13
ZERO/CAL	ZERO	14
FREQ	FREQ	15
◑	CONTrast	16
⏻	POWer	17
DEL	DELete	18
MENU ↵	ENTer	19
ESCAPE/LOCAL	ESCape	20
↑	UP	21
↓	DOWN	22
←	LEFT	23
→	RIGHt	24

Note: *The R&S NRP can be switched off via remote control by means of the* `SYST:KEY POWER` *command.*

SYSTem:PRESet

Resets the R&S NRP to default (*RST) values. No difference is made between reset and preset values. The same settings are made by SYST:PRES and *RST. For preset values see Table 6-30 .

Table 6-30: Preset and *RST value

Command	Preset and *RST value	Remark
CALC[1..8]:LIM:BEEP	OFF	No audible signal in case of limit violations.
CALC[1..8]:LIM:FAIL?	0	Limit violation.
CALC[1..8]:LIM:FCO?	0	Number of limit violations is reset.
CALC[1..8]:LIM:UPP:DATA	0 W or 0 DB	Upper limit value for measurements.
CALC[1..8]:LIM:UPP:STAT	OFF	No monitoring function for upper limit value.
CALC[1..8]:LIM:LOW:DATA	0 W or 0 DB	Lower limit value for measurements.
CALC[1..8]:LIM:LOW:STAT	OFF	No monitoring function for lower limit value.
CALC[1..8]:MATH	→ For command description see 6.23	The calculate block returns the measured value of the sensor assigned to the primary channel.
CALC[1..8]:REL	0 DBM or 0 DB	-
CALC[1..8]:REL:POW	0 DBM	-
CALC[1..8]:REL:RAT	0 DB	-
CALC[1..8]:REL:STAT	OFF	Measurements are not converted into a reference value.
DISP:ILL	-	Display lighting remains unchanged and can be activated by pressing .
DISP:MESS	OFF	Do not display messages.
DISP:MESS:TEXT	""	User text deleted.
DISP:MESS:TYPE	MESS	Messages cannot be confirmed manually.
DISP[1..4]:FORM	DIG	Digital result display.
DISP[1..4]:MET:LOW	-90 DBM -120 DB	Lower limit value for analog result display.
DISP[1..4]:MET:UPP	70 DBM 60 DB	Upper limit value for analog result display.
DISP[1..4]:NAME	""	Text to be displayed in result window.
DISP[1..4]:RES	0.01	Measurement accuracy and display accuracy.
DISP[1..4]:SEL	1	Selection of first result window.
DISP[1..4]:SIZE	NORM	Automatic window sizes.
DISP[1..4]	ON | OFF	A window will automatically be opened for each sensor.
MEM:...	-	The settings in the MEMory command system will not be affected.
OUTP:ROSC	OFF	Test generator is switched off.
SENS[1..4]:AVER	ON | OFF	Depending on sensor.
SENS[1..4]:AVER:COUN[?]	<NR1>	Depending on sensor.
SENS[1..4]:AVER:COUN:AUTO	OFF	Depending on sensor.
SENS[1..4]:AVER:COUN:AUTO:MTIMe[?]	<NRf>	Depending on sensor.

Command	Preset and *RST value	Remark
SENS[1..4]:AVER:COUN:AUTO:RES[?]	<NRf>	Depending on sensor.
SENS[1..4]:AVER:COUN:AUTO:SLOT	<NR1>	Depending on sensor.
SENS[1..4]:AVER:COUN:AUTO:NSR[?]	<NRf>	Depending on sensor.
SENS[1..4]:AVER:COUN:AUTO:TYPE[?]	RES | NSR	Depending on sensor.
SENS[1..4]:AVER:TCON	MOV REP	In manual control. In remote control.
SENS[1..4]:CORR:DCYC	<NRf>	Depending on sensor.
SENS[1..4]:CORR:DCYC:STAT	ON |OFF	Depending on sensor.
SENS[1..4]:CORR:FDOT	-	No change.
SENS[1..4]:CORR:FDOT:STAT	OFF	
SENS[1..4]:CORR:OFFS	<NRf>	Depending on sensor.
SENS[1..4]:CORR:OFFS:STAT	ON | OFF	Depending on sensor.
SENS[1..4]:FREQ	-	No change.
SENS[1..4]:FUNC	"POW:AVG"| "POW:BURS:AVG"| "POW:TSL:AVG"| "XTIM:POW"	Depending on sensor.
SENS[1..4]:APER	<NRf>	Depending on sensor.
SENS[1..4]:BUFF:STAT	ON | OFF	Depending on sensor.
SENS[1..4]:BUFF:SIZe	<NR1>	Depending on sensor.
SENS[1..4]:TSL:COUNt	<NR1>	Depending on sensor.
SENS[1..4]:TSL:WIDTh	<NRf>	Depending on sensor.
SENS[1..4]:BURS:DTOL	<NRf>	Depending on sensor.
SENS[1..4]:RANG	1 | 2 | 3	Depending on sensor.
SENS[1..4]:RANG:AUT	ON | OFF	Depending on sensor.
SENS[1..4]:RANG:CLEV	<NRf>	Depending on sensor.
SENS[1..4]:SAMP	FREQ1 | FREQ2	Depending on sensor.
SENS[1..4]:SMO:STAT	ON | OFF	Depending on sensor.
SENS[1..4]:AC:RANG	1 | 2 | 3	Depending on sensor.
SENS[1..4]:AC:RANG:AUT	ON | OFF	Depending on sensor.
SENS[1..4]:AC:RANG:CLEV	<NRf>	Depending on sensor.
SENS[1..4]:SWE:AVER	ON | OFF	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN[?]	<NR1>	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO	OFF	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO:MTIMe[?]	<NRf>	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO:RES[?]	<NRf>	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO:POIN	<NR1>	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO:NSR[?]	<NRf>	Depending on sensor.
SENS[1..4]:SWE:AVER:COUN:AUTO:TYPE[?]	RES | NSR	Depending on sensor.
SENS[1..4]:SWE:AVER:TCON	MOV REP	In manual control. In remote control.
SENS[1..4]:SWE:OFFS:TIME	<NRf>	Depending on sensor.
SENS[1..4]:SWE:POINt	<NR1>	Depending on sensor.
SENS[1..4]:SWE:TIME	<NRf>	Depending on sensor.
SENS[1..4]:SWE:REAL	ON|OFF	Depending on sensor.
SENS[1..4]:TIMing:EXCL:STARt	<NRf>	Depending on sensor.
SENS[1..4]:TIMing:EXCL:STOP	<NRf>	Depending on sensor.
SYST[1..4]:SPEed	NORM	Depending on sensor.
INIT[1..4|:ALL]:CONT	OFF	Depending on sensor.
TRIG[1..4|:ALL]:ATR	ON | OFF	Depending on sensor.

Command	Preset and *RST value	Remark
TRIG[1..4|:ALL]:COUN	<NR1>	Depending on sensor.
TRIG[1..4|:ALL]:DELay	<NRf>	Depending on sensor.
TRIG[1..4|:ALL]:DEL:AUTO	ON|OFF	Depending on sensor.
TRIG[1..4|:ALL]:HOLD	<NRf>	Depending on sensor.
TRIG[1..4|:ALL]:HYST	<NRf>	Depending on sensor.
TRIG[1..4|:ALL]:LEV	<NRf>	Depending on sensor.
TRIG[1..4|:ALL]:SLOP	POS | NEG	Depending on sensor.
TRIG[1..4|:ALL]:SOUR	IMM | HOLD | EXT | INT | BUS	Depending on sensor.
UNIT[1..8]:POW	DBM	Logarithmic result scaling.
UNIT[1..8]:RAT	DB	Logarithmic result scaling.

SYSTem:SENSor:INFO? [<string>]

Returns information on a sensor. <string> 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. The permissible values for <string> depend on the sensor. For details refer to the documentation of the corresponding sensor.

Value range: depending on sensor

SYSTem:SENSor[1..4]:RESet

From the point of view of the R&S NRP basic unit, the sensors are stand-alone measuring devices. They communicate with the R&S NRP via a command set complying with SCPI.

SYST:SENS[1..4]:RES prompts the basic unit to send an *RST to the respective sensor. Measurements in progress are interrupted.

SYSTem:SPEed NORMal | FAST

The data processing speed of the R&S NRP can be increased when FAST is selected. The display is switched off and the measured values are no longer displayed since the continuous update of the screen content requires computation time.

***RST value:** NORM

SYSTem:TIME[?] <hour>,<minute>,<second>

Parameter	Value range
<hour>	0 ... 24
<minute>	0 ... 59
<second>	0 ... 59

Sets the time. Since the R&S NRP has no battery-backed clock, the time has to be reset each time a new measurement is started if the clock was not set after the last power-on of the R&S NRP. (→SYSTem:DATE[?] <year>,<month>,<day>).

SYSTem:VERSion?

Returns a string that contains the current version number of the SCPI standard.

TEST

Table 6-31: Commands of the TEST system

Command	Parameter	Unit	Remark
TEST :SENSor[1..4]?			Query only

TEST:SENSor[1..4]?

Triggers a selftest of the respective sensor. If the sensor detects an error, 1 is returned; otherwise the response is 0. TEST:SENS[1..4] complements the IEEE 488.2 command *TST? which tests the entire device. An error description is stored in the error table which can be queried with SYST:ERR? in the remote control mode and called under System→Error in case of manual control.

TRIGger

The trigger commands are used to configure the timing conditions for the start of a measurement.

Note: *When the sensors are connected to the R&S NRP, they inform the device about the SENSe and TRIGger commands supported and about the value ranges for parameters. This applies to both numeric and text parameters. For this reason, no fixed ranges are specified with these commands; the ranges can be obtained from the respective sensor manual.*

Table 6-32: Commands for setting the trigger system of a sensor

Command	Parameter	Unit	Remark
ABORt[1..4|:ALL]			No query
INITiate[1..4|:ALL]			
:CONTinuous[?]	ON | OFF		
[:IMMediate]	-		No query
TRIGger[1..4|:ALL]			
:ATRigger[:STATe][?]	ON | OFF		
:COUNt[?]	<int_value>	-	
:DELay[?]	<float_value>	S	
:AUTO[?]	ON | OFF		
:HOLDoff[?]	<float_value>	S	
:HYSTeresis[?]	<float_value>	DB|PCT	
[:IMMediate]	-		No query
:LEVel[?]	<float_value>	DBM|W	
:SLOPe[?]	POSitive | NEGative		
:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		

ABORt[1..4|:ALL]

Immediately sets the respective sensors to the IDLE state. Measurements in progress are interrupted. If INIT:CONT ON is set, a new measurement is immediately started since the trigger system is not influenced.

INITiate[1..4|:ALL]:CONTinuous[?] ON | OFF

Selects either single-shot or continuous (free-running) measurement cycles. In the course of a measurement cycle, a sensor passes through the IDLE, INITIATED, WAIT_FOR_TRG and MEASURING states before it is again set to the IDLE (INIT:CONT OFF) or the INITIATED (INIT:CONT ON) state. The settings are not changed when control is switched from manual to remote. INIT:CONT ON is set when remote control is switched back to manual control.

INIT:CONT ON Continuous measurements are performed. If a measurement is completed, the respective sensors do not return to the IDLE state but are immediately set to INITIATED and then to WAIT_FOR_TRG.

INIT:CONT OFF A measurement cycle is only performed once. After completion, the sensors remain in the IDLE state. INIT:CONT OFF has no effect when the sensor is already in the IDLE state. A measurement in progress is completed.

***RST value:** depending on sensor

INITiate[1..4|:ALL][:IMMediate][?]

This command starts a single-shot measurement. The respective sensor goes to the INITIATED state. The command is completely executed when the sensor returns to the IDLE state. The command is ignored when the sensor is not in the IDLE state or when continuous measurements are selected (INIT:CONT ON). The command is only fully executed when the measurement is completed and the trigger system has again reached the IDLE state. INIT is the only remote control command that permits overlapping execution. Other commands can be received and processed while the command is being executed.

Note: *INIT:IMM invalidates all previous measuring results. A FETCh? command following INIT will thus always return a new measurement result.*

Error messages:
28 "**Sensor not idle**": The sensor is not in the IDLE state.

TRIGger[1..4|:ALL]:ATRigger[:STATe][?] ON | OFF

When TRIG:ATR is set to ON, the WAIT_FOR_TRG state is automatically exited when no trigger event occurs within a period that corresponds to the reciprocal of the display update rate.

***RST value:** depending on sensor

TRIGger[1..4|:ALL]:COUNt[?] <int_value>

Sets the number of measurement cycles to be performed when the measurement is started with INIT.

Unit: 1
Value range: depending on sensor
***RST value:** depending on sensor

TRIGger[1..4|:ALL]:DELay[?] <float_value>

Defines the delay between the trigger event and the beginning of the actual measurement (integration).

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

TRIGger[1..4|:ALL]:DELay:AUTO[?] ON | OFF

TRIG:DEL:AUTO ON ensures by means of an automatically determined delay that a measurement is started only after the sensor has settled. This is important when thermal sensors are used. The automatically determined delay is ignored when a longer period was set with TRIG[1..4]:DEL.

***RST value:** depending on sensor

TRIGger[1..4|:ALL]:HOLDoff[?] <float_value>

Defines a period after a trigger event within which all further trigger events are ignored.

Unit: S
Value range: depending on sensor
***RST value:** depending on sensor

TRIGger[1..4|:ALL]:HYSTeresis[?] <float_value>

This command is used to specify how far the signal level has to drop below the trigger level before a new signal edge can be detected as a trigger event. Thus, this command can be used to eliminate the effects of noise in the signal on the transition filters of the trigger system.

Unit: DB | PCT
Default unit: DB
Value range: depending on sensor
***RST value:** depending on sensor

TRIGger[1..4|:ALL][:IMMediate]

Performs triggering and ensures that the sensor directly changes from the WAIT_FOR_TRG state to the MEASURING state irrespective of the selected trigger source (TRIG:SOUR). A trigger delay set with TRIG:DEL is ignored but not the automatic delay determined when TRIG:DEL:AUTO:ON is set. When the trigger source is HOLD, a measurement can only be started with TRIG.

Error messages:
-211 "**Trigger ignored**": The sensor is not in the WAIT_FOR_TRG state.

TRIGger[1..4|:ALL]:LEVel[?] <float_value>

Determines the power a trigger signal must exceed before a trigger event is detected. This setting is only used for the trigger signal source (TRIG:SOUR) INTernal.

Unit: DBM | W
Default unit: DBM
Value range: depending on sensor
***RST value:** depending on sensor

TRIGger[1..4|:ALL]:SLOPe[?] POSitive | NEGative

This command determines whether the rising (POSitive) or the falling (NEGative) edge of the signal is used for triggering.

***RST value:** depending on sensor

TRIGger[1..4|:ALL]:SOURce[?]
BUS | EXTernal | HOLD | IMMediate | INTernal

Sets the trigger signal source for the WAIT_FOR_TRG state.

BUS The trigger event is initiated by TRIG:IMM or *TRG. In this case, the setting for TRIG:SLOP is meaningless.

EXTernal Triggering is performed with an external signal applied to the trigger connector. The TRIG:SLOP command determines whether the rising or the falling edge of the signal is to be used for triggering. Waiting for a trigger event can be skipped by TRIG:IMM.

IMMediate The sensor does not remain in the WAIT_FOR_TRG state but immediately changes to the MEASURING state.

HOLD A measurement can only be triggered when the command TRIG:IMM is executed.

INTernal The sensor determines the trigger time by means of the signal to be measured. When this signal exceeds the power set by TRIG:LEV, the measurement is started after the time set by TRIG:DEL. Similar to TRIG:SOUR EXT, waiting for a trigger event can also be skipped by TRIG:IMM.

***RST value:** depending on sensor

UNIT

Table 6-33: Commands of the UNIT system

Command	Parameter	Unit	Remark
UNIT[1..8] :POWer[?] :RATio[?]	 DBM | W DB | PCT		

UNIT[1..8]:POWer[?] DBM | W

Selects either a linear (W) or logarithmic (DBM) scale for the display of absolute measured values.

***RST value:** DBM

UNIT[1..8]:POWer:RATio[?] PCT | DB

Selects either a linear (PCT) or a logarithmic (DB) scale for the display of relative measured values.

***RST value:** DB

List of Remote Control Commands

The R&S NRP supports remote control commands to the SCPI 1999.0 standard.

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Compatibility Information

This section contains information regarding the compatibility of the R&S NRP remote control commands with those of the E4418B and E4419B power meters from Agilent.

The R&S NRP is largely downward-compatible to the above-mentioned devices but offers additional capabilities.

Table 6-34: Compatibility information about remote control commands

E4418B/E4419B command	**Compatibility information**
`SENSe[1|2]:CORRection :CSET[1]|CSET2[:SELect]` and `SENSe[1|2]:CORRection :CSET[1]|CSET2:STATe`	The R&S NRP does not recognize any tables with frequency-dependent calibration values since the sensors have to be calibrated only once in production. For this reason, there is no compliance with `CSET1.` Tables with frequency-dependent offset correction values can be defined and addressed via :`CSET2` (Agilent and R&S NRP) or .`:FDOTable` (R&S NRP only).
`SENSe[1|2]:CORRection:GAIN[1]?`	Has the same effect as `SENSe[1..2]:CORRection:CFACtor?`
`SENSe[1|2]:CORRection:GAIN2[?]`	Has the same effect as `SENSe[1..2]:CORRection:OFFSet[?].` With `:GAIN2`, no unit may be specified. Unit 1 is valid.
`SENSe[1|2]:CORRection:LOSS2[?]`	Corresponds to the reciprocal of `SENSe[1..2]:CORRection:OFFSet[?].` With `:LOSS2`, no unit may be specified. Unit 1 is valid.
`SENSe[1|2]:CORRection:GAIN3[?]`	Has the same effect as `SENSe[1..2]:CORRection:DCYCle[?].` With `:GAIN3`, no unit may be specified. Unit 1 is valid.
`SENSe[1|2]:CORRection:GAIN4?`	Has the same effect as `SENSe[1..2]:CORRection:FDOFfset[:INPut][:MAGNitude]?.`

`:AC`	Agilent recognizes the keyword `:AC` of some high-level commands and `SENSe` commands:
	`CONFigure | READ | MEASure | FETCh`
	`[:SCALar][:POWer:AC]`
	`:RELative`
	`:DIFFerence`
	`:DIFFerence:RELative`
	`:RATio`
	`:RATio:RELative`
	`SENSe:POWer:AC:RANGe:AUTO` The R&S NRP also recognizes these commands but `:AVG` should be used instead of `:AC` since no AC components are measured and the designation in the R&S NRP is not used in the sense of SCPI.

Interfaces

IEC/IEEE Bus Interface

The R&S NRP is fitted with an IEC/IEEE bus interface as standard. The connector in line with IEEE 488 is located on the rear panel. A controller can be connected to this interface for remote control. A shielded cable is used for the connection.

Characteristics of the Interface

- 8-bit parallel data transmission
- Bidirectional data transmission
- Three-wire handshake
- Data transmission rate up to 350 Kbyte/s
- Connection of up to 15 devices
- Max. length of connecting cables: 15 m (length of single cable: 2 m)
- Wired OR links when several devices are connected in parallel.

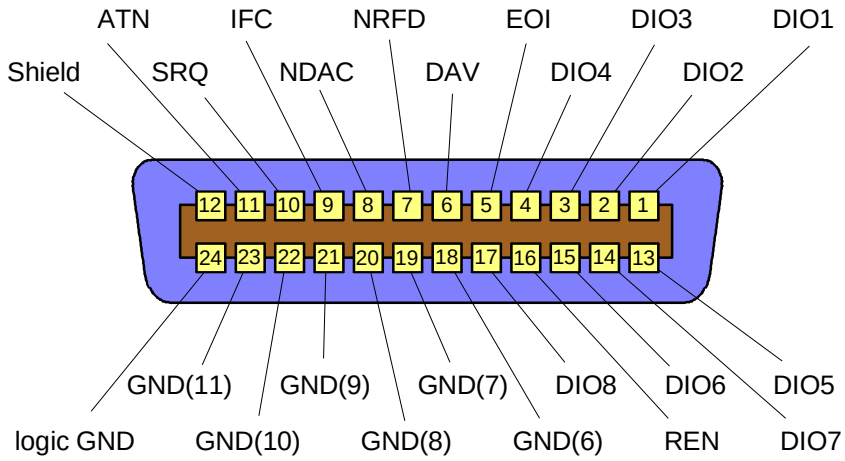

Fig. 6-11: Pin assignment of IEC/IEEE-bus interface

Bus Lines

1. Data bus with 8 lines DIO 1 to DIO 8

Transmission is bit-parallel and byte-serial in ASCII/ISO code. DIO 1 is the least-significant and DIO 8 the most-significant bit.

2. Control bus with 5 lines

IFC (Interface Clear)
Active LOW resets the interfaces of connected devices to the default state.

ATN (Attention)
Active LOW indicates the transmission of interface messages;
non-active HIGH indicates the transmission of device messages.

SRQ (Service Request)
Active LOW enables a device to send a service request to the controller.

REN (Remote Enable)
Active LOW allows switchover to the remote control mode.

EOI (End or Identify)
together with ATN has two functions:
ATN = HIGH: active LOW marks the end of data transmission.
ATN = LOW: active LOW triggers a parallel poll.

3. Handshake bus with three lines

DAV (Data Valid)
Active LOW signals a valid data byte on the data bus.

NRFD (Not Ready For Data)
Active LOW signals that one of the connected devices is not ready to accept data.

NDAC (Not Data Accepted)
Active LOW until the connected device has accepted the data on the bus.

Interface Functions

Devices remote-controlled via an IEC/IEEE-bus may be equipped with different interface capabilities. Table 6-35 shows the IEC/IEEE bus capabilities of the R&S NRP.

For coding of the different capabilities see the IEEE488 standard.

Table 6-35: Interface functions of IEC/IEEE bus

IEEE488 Standard Code	Interface capabilities
SH1	Source handshake
AH1	Acceptor handshake
L3	Listener function, Listen-Only mode, unaddressed for MSA and TPAS, recognizes END and EOS.
LE3	Extended Listener function, Listen-Only mode, unaddressed for MSA and TPAS, recognizes END and EOS.
T5	Talker function, capability to respond to serial poll, Talk-Only mode, unaddressed on MLA, sends END or EOS.
TE5	Extended talker function, capability to respond to serial poll, Talk-Only mode, unaddressed for MLA and LPAS, sends END or EOS.
SR1	Service request function
PP1	Remote parallel-poll function
PP2	Local parallel-poll function
RL1	Remote/local switchover function
DC1	Device clear
E2	3-state driver (open-collector driver during parallel poll)
DT1	Device trigger
C0	No controller capabilities

Interface Messages

Interface messages are transmitted to the device on data lines, where the ATN is set to active LOW. They are used for communication between the controller and the R&S NRP.

Common Commands

Common commands are in the code range 0x10 to 0x1F. They affect all devices on the bus without any addressing being required.

Table 6-36: Common commands

Command	Effect on device
DCL (Device Clear)	Interrupts processing of received commands and sets the command processing software to a defined initial state. This command does not change the device setting.
IFC (Interface Clear)	Resets the interfaces to their initial condition.
LLO (Local Lockout)	Manual switchover to LOCAL is disabled.
SPE (Serial Poll Enable)	Ready for serial poll.
SPD (Serial Poll Disable)	End of serial poll.
PPU (Parallel Poll Unconfigure)	End of parallel poll query status.

Addressed Commands

Addressed commands are in the code range 0x00 to 0x0F hex. They only affect devices addressed as a listener.

Table 6-37: Addressed commands

Command	Effect on device
SDC (Selected DeviceClear)	Interrupts processing of received commands and sets the command processing software to a defined initial state. This command does not change the device setting.
GTL (Go to Local)	Change to local mode (manual control).
PPC (Parallel Poll Configure)	Configures device for parallel poll.

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I Programming Measurements with the R&S NRP

Measuring with high-level commands

The R&S NRP is based on the instrument model defined in the SCPI 1999.0 standard. This model provides a number of logic blocks that can be configured via remote-control commands. The R&S NRP is provided with high-level measurement commands that automatically perform the most important settings and simplify measurements, thus making it unnecessary to completely configure these blocks for each measurement. Only the high-level commands are described, starting with the simplest command, which is expanded in the following sections.

Note the following for the syntax of commands: There is a short and a long form for the commands. The short form is normally used. However, commands are sometimes indicated in their long form so that their meaning is easier to understand. The R&S NRP makes no distinction between upper case and lower case letters; they are only used to distinguish between the short and long form.

The simplest measurement

The simplest way to obtain a measured value is to use the high-level measurement command

```
MEAS?,
```

which configures sensor 1 in the ContAv mode, starts a measurement and always outputs a result that is stored in the output queue. The following settings are performed:

- `INIT:CONT OFF`
- `TRIG:SOUR IMM`
- `TRIG:COUN 1`
- `TRIG:DEL:AUTO ON`
- `SENS:AVER:STAT ON`
- `SENS:AVER:COUN:AUTO ON`
- `SENS:AVER:COUN:AUTO:TYPE RES`
- `SENS:AVER:COUN:AUTO:RES 3`
- `CALC:MATH "(SENS1)"`
- `CALC:REL:STAT OFF`

The command can also be used with a list of parameters, which are separated by a comma and allow the measurement accuracy and the addressed sensor to be selected:

```
MEAS? DEF, <resolution>, <source_list>
```

The first parameter should always assume the `DEF` value; it is ignored and is available only for reasons of compatibility.

The second parameter may assume the values `1`, `2`, `3` and `4`. It specifies the number of places up to which the measurement result should be noise-free. With linear units, the setting corresponds to the number of significant places that are noise-free; with logarithmic units, `1`, `2`, `3` and `4` correspond to a resolution of 1, 0.1, 0.01 and 0.001 (number of decimal places). With a `<resolution>` of 3, two decimal places are thus noise-free with logarithmic display. The default setting is 3.

The third parameter selects a sensor. It has the syntax `(@`*n*`)`, where *n* can assume the values `1` to `4`. The default setting is `(@1)`.

Relative measurements

If the measurement results are to be output not as absolute values, but relative to a reference value, the keyword `:RELative` can be added to the measurement command. The result is then divided by a value that was previously set by means of `CALC:REL:POW` or `CALC:REL:AUTO ONCE`.

```
MEAS?
CALC:REL:AUTO ONCE
MEAS:REL?
```

The first `MEAS` command determines the reference value, which is acquired and stored with `CALC:REL:AUTO ONCE`. The second measurement command `MEAS:REL?` and all other `MEAS:REL?` commands will divide the absolute measured value by the stored reference value.

`CALC:REL:POW <float_value>` is used to define such a reference value.

```
CALC:REL:POW 0 DBM
MEAS:REL?
```

All measured values are then divided by 0 dBm (1 mW) prior to being transferred to the user.

The following section describes an extension of the MEAS command in which the result no longer carries a power unit, but represents a power ratio. The reference value also must have a power unit and be set with `CALC:REL:RAT`. The R&S NRP stores the reference values for power values and power ratios independently of each other and automatically uses the correct reference value depending on the unit of the measurement result.

The `CALC:REL` command is available for entering the reference value. It assumes a numeric parameter whose unit is determined from the current device settings. This command is provided only for reasons of compatibility and should not be used unless avoidable.

Processing the results of two sensors

The R&S NRP offers measurement commands for processing the results of two sensors. The calculated result can also be partly referenced to a stored reference value.

The measurement commands are obtained by adding one of the following keywords:

`:DIFF`	(difference)
`:DIFF:REL`	(difference with reference value)
`:RAT`	(ratio)
`:RAT:REL`	(ratio with reference value)
`:SWR`	(standing wave ratio)
`:RLOS`	(return loss)
`:REFL`	(reflection coefficient)

The list of parameters is modified for these commands since two sensors have to be entered in the `<source_list>`.

Example:

```
MEAS:RAT DEF,3,(@1),(@4)
```

A CALCulate block is used for processing the measured values. Each CALCulate block has two input channels called the primary and secondary channel. In the above example, the primary channel is assigned sensor 1 and the secondary channel sensor 4 via the `<source_list>`. The measurement result is the ratio of the results from sensors 1 and 4.

Example:

```
MEAS:SWR DEF,2,(@1),(@2)
```

It is assumed that sensor 1 delivers the forward power of a wave and sensor 2 the reflected power of a wave. The measurement result represents the SWR of the two power values:

$$P = \frac{1+\sqrt{(@2)/(/@1)}}{1-\sqrt{(@2)/(/@1)}}$$

Note that the unit is automatically set to percent (refer to Selecting the output unit for measured values).

Selecting a measurement mode

Other MEAS commands are available for measurements to be performed in a mode other than the ContAv mode. The short form of these commands is obtained by adding a keyword for the measurement mode to keyword MEAS.

Timeslot measurement:
`MEAS:TSLot? <tslot_width>,<no_slots>,<start_exclude>,<stop_exclude>`

BurstAv measurement:
`MEAS:BURSt? <dtolerance>,<start_exclude>,<stop_exclude>`

Scope measurement:
`MEAS:XTIMe? (<scope_size>),<capture_time>`

Measurement in the ContAv mode with data buffering:
`MEAS:ARRay? <tslot_width>,<no_slots>,<start_exclude>,<stop_exclude>`

Note: *In the Timeslot mode, the trigger source is set to `EXTernal`. In the BurstAv mode, it is not modified but ignored. Triggering in response to the signal is performed as if `TRIGger:SOURce INTernal` were set.*

These commands have the specified parameters, whose meanings are explained in the operating manual. In addition, parameters `DEF, <resolution>, <source_list>` can be optionally specified as for the `MEAS?` command.

Examples:

`MEAS:TSLot? 577 us, 8, 18 us, 18 us`
A timeslot measurement of a GSM signal is performed (8 timeslots with a length of 577 µs each). 18 µs at the beginning and the end of the timeslots are ignored. The measurement is carried out with sensor 1 (default). The instrument is triggered by an external signal, which must be routed to the R&S NRP rear panel via the trigger input. The measurement result is a list of 8 measured values separated by a comma for the timeslots.

`MEAS:BURSt? 5 us, 10 us, 0 us, DEF, 3, (@2)`
Sensor 2 measures in the BurstAv mode. Triggering (in response to a rising edge) is internal. At the beginning of the power pulse, 10 µs are ignored to avoid overshoots in the signal, which could distort the measurement result. If the power falls below the trigger level but does not exceed 5 µs (dropout time) the measurement will not be stopped. The measurement result is noise-free within the first 3 places and it is measured with sensor 2 (`(@2)`).

`MEAS:XTIMe? (256), 577 us`
Within the next 577 µs, 256 measured values are recorded and displayed with respect to time in te same manner as with an oscilloscope in order to display the power characteristics. There is no triggering (`TRIG:SOUR IMM`); the measurements are started after the command is received from the R&S NRP. After a partial measurement has been completed, the next one is started. If the trigger source setting is to be changed, `MEAS:XTIMe?` must be replaced by the `CONF:XTIMe` and `READ:XTIMe?` commands, between which user-defined settings can be performed. Dividing `MEAS?` into the `CONF` and `READ?` commands is described further down. The measurement result is a list of 256 measured values separated by a comma.

`MEAS:ARRay? (1000)`
1000 measured values are recorded in the ContAv mode. After termination of the last measurement, the results are stored in the output queue. There is no triggering as in the ContAv mode. The measurement result is a list of 1000 measured values separated by a comma.

The keywords for processing two sensors can be added to the `MEAS:TSL`, `MEAS:BURS` and `MEAS:ARRay` commands, but the `:SWR`, `:RLOS` and `:REFL` functions are not available.

Example:
`MEAS:TSL:RAT? 577 us, 8, 18 us, 18 us, DEF, 3, (@1), (@3)`
The above timeslot example is extended to two sensors. The measurement result is a list of 8 measured values separated by a comma for the 8 timeslots; these values were obtained by division from the measured values of sensors 1 and 3.

Selecting the output unit for measured values

So far, no information has been given on the unit of the measured values. It is possible to modify the output unit of the measured values. A distinction is made as to whether the result represents a power or a power ratio. Relative measurements always deliver power ratios. This also applies to the :RATio, :SWR, :RLOS and :REFL functions. The units are set by means of the following commands:

```
UNIT:POWer DBM | W | DBUV  and
UNIT:RATio DB | DPCT | O
```

The default settings are DBM for power values and DB for power ratios.

Physical unit	SCPI notation	Meaning
dBm	DBM	Power in dB referenced to 1 mW: x / W = 10 log (x / (1 mW)) / dBm
Watt	W	
dBµV	DBUV	Power in dB referred to $(1\mu V)^2$ / 50 Ω: x dBm ≈ (x + 107) dBµV
dB	DB	
Δ%	DPCT	Deviation from 100% in %: x Δ% = (x + 100) %
1	O	

When the :SWR, :RLOS and :REFL functions are used, the output unit, however, is implicitly set by the MEAS command:

Measurement function	Output unit
:SWR	O
:RLOS	DB
:REFL	O

Note: *The UNIT commands affect the parameters of the following commands: CALC:LIMit:UPPer, CALC:LIMit:LOWer, CALC:RELative, DISP:METer:UPPer and DISP:METer:LOWer.*

Division of MEAS?

MEAS? can be divided into other high-level measurement commands.

```
MEAS?   ⇔   CONF [<parameters list>]
            READ? [<parameters list>]
```

The CONF command configures the measurement, whereas READ? starts the measurement, and calculates and provides the result. This division offers two advantages:

1. The measurement has to be configured only once and several measurements (with several READ? commands) can be performed in succession. This means better performance as compared to measurements performed with MEAS?, since the time for configuring the measurement is only used once.
2. After CONF, settings can be adapted to user's requirements by means of low-level commands (see below).

Note: *If a list of parameters is indicated for the READ command, it must correspond to the list for the preceding CONF command.*

After a measurement has been completed, i.e. the data from the sensors is available, it is sometimes interesting to evaluate this data several times without starting a new measurement each time. Since this is not possible with the above commands, the READ? command can be replaced by the INIT and FETCh? commands.

```
READ?   ⇔   INIT
            FETCh? [<list of parameters>]
```

FETCh? evaluates existing data if the data is valid. FETCh? may select another calculation function if the measurement can be evaluated with the available measured data.

Example:
The following sequence of commands provides the difference between measured values from sensors 1 and 2 by means of FETCh:DIFF?, which measure in the ContAv mode as the default setting.

```
CONF:DIFF
INIT:ALL
FETCh:DIFF?    (OK)
FETCh:RAT?     (OK)
FETCh:BURst?   ( → -221, "Settings conflict")
```

The FETCh:RAT? command then delivers the ratios of the two measured values. This is possible without a new measurement, since the required data is available. The last FETCh command requires a result that was measured in the BurstAv mode. Such a measured value is not available and thus, this command will generate a SCPI error (-221, "Settings conflict").

FETCh? immediately delivers a measured value if a valid result is available. If no measured value is available, the R&S NRP waits for such a value and then answers the query. During this time, no other command should be sent to the R&S NRP, since the query has to be answered first. If a command is sent to the R&S NRP, the SCPI error -410, "Query interrupted", is output.
However, FETCh? should wait only if a measurement result is expected, since command processing is blocked if a command is not answered. If FETCh? is executed although no measured values are expected, the SCPI error -214, "Trigger deadlock", is output. This may occur if the trigger source is set to BUS or HOLD with low-level TRIG:SOUR and FETCh? immediately follows INIT.

Example:

```
CONF
TRIG:SOUR BUS
INIT
FETCh?
```

(→ -214, "Trigger deadlock", `*TRG` or `GET` is not possible if `FETCh?` is waiting).

Trigger state system

The accuracy of a result largely depends on how accurately the sequence of a measurement can be determined. The R&S NRP manages a trigger state system to SCPI 1999.0 for each sensor to define the exact start and stop time of a measurement. This system defines the sequence of a measurement cycle. 4 different device states are defined in the trigger state system implemented in the R&S NRP.

IDLE The R&S NRP is in the idle state and performs no measurement. On power-up of the R&S NRP, it is in the LOCAL mode and in the IDLE state. All connected sensors are set to `INIT:CONT ON` to allow measurements to be continuously displayed. Thus, the IDLE state is exited and the instrument is again in this state if `INIT:CONT OFF` is sent via the remote control.

INITIATED This state is a transition state, which is exited immediately after it has been entered. It has been defined so as to allow the user to decide whether the next measurement cycle is to be immediately started (`INIT:CONT ON` or all cycles defined via `TRIG:COUNT` have not yet been processed) or the R&S NRP returns to the IDLE state. The state is only entered internally and is not noticed by the user.

WAIT_FOR_TRG The R&S NRP waits for a trigger event. The source for this event is set via `TRIG:SOUR`. When the event defined in this way occurs, the R&S NRP enters the MEASURING state.

MEASURING As long as the R&S NRP measures data, it remains in this state and exits it immediately after completion of the measurement.

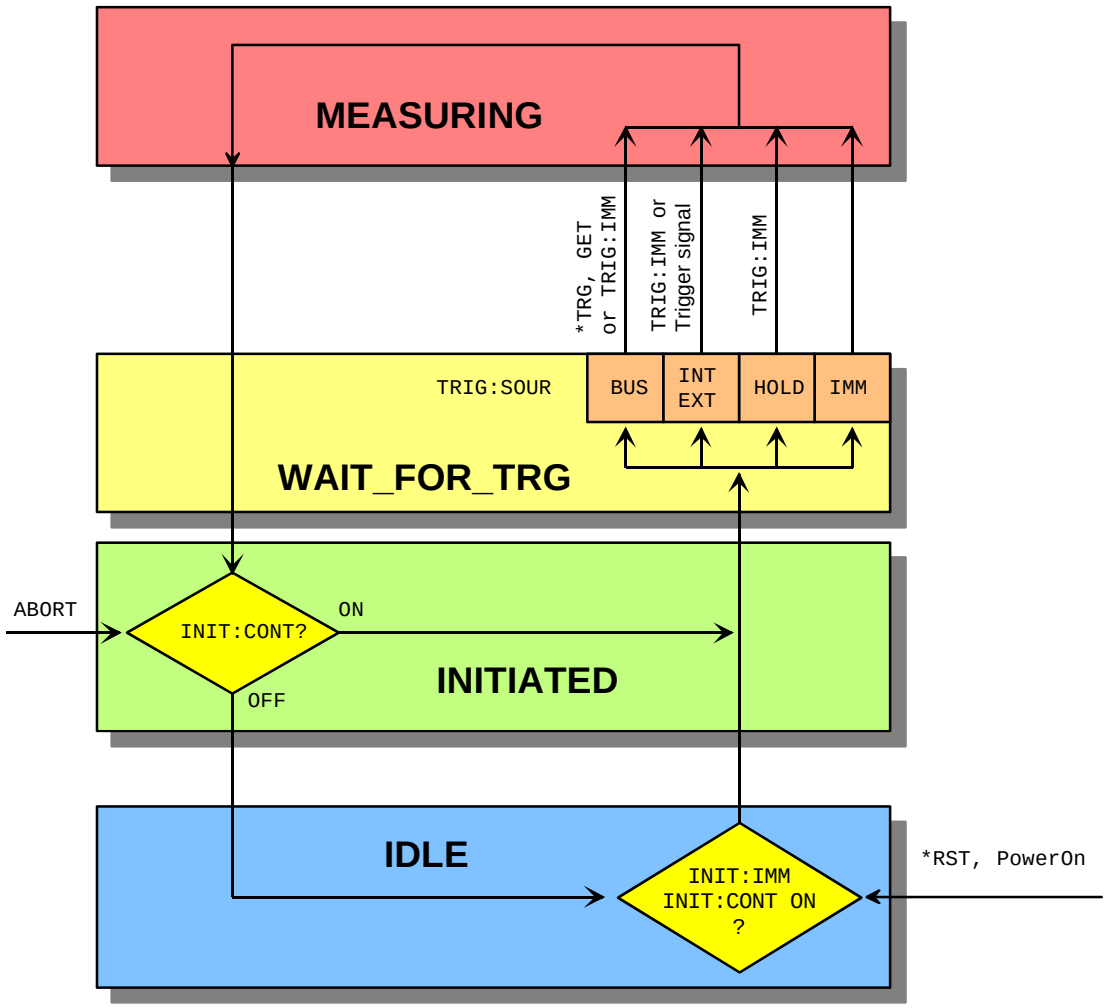

Fig. I-1: Overview of basic relationships in the trigger state system

Fig. I-1: Overview of basic relationships in the trigger state system shows the basic structure of the trigger system. It is possible to improve the sequence of measurement using the commands from the TRIGger command system.

Logic relationship of command systems SENSe, CALCulate and UNIT

The following section provides an overview of the measurement procedure of the R&S NRP. The commands are mentioned as examples. These commands are described in detail in chapter 6.

To perform measurements with the R&S NRP, the user should have a good understanding of the trigger system and be familiar with the result processing. The measured values delivered by the sensors cannot be directly queried. As shown in Fig. I-2: Processing of measured values in the R&S NRP, the raw data is first determined in the sensors taking into account the SENSe settings. It is then transferred to the CALCulate blocks where the measured values of up to two sensors are processed and made available to the user in the unit defined by `UNIT`.

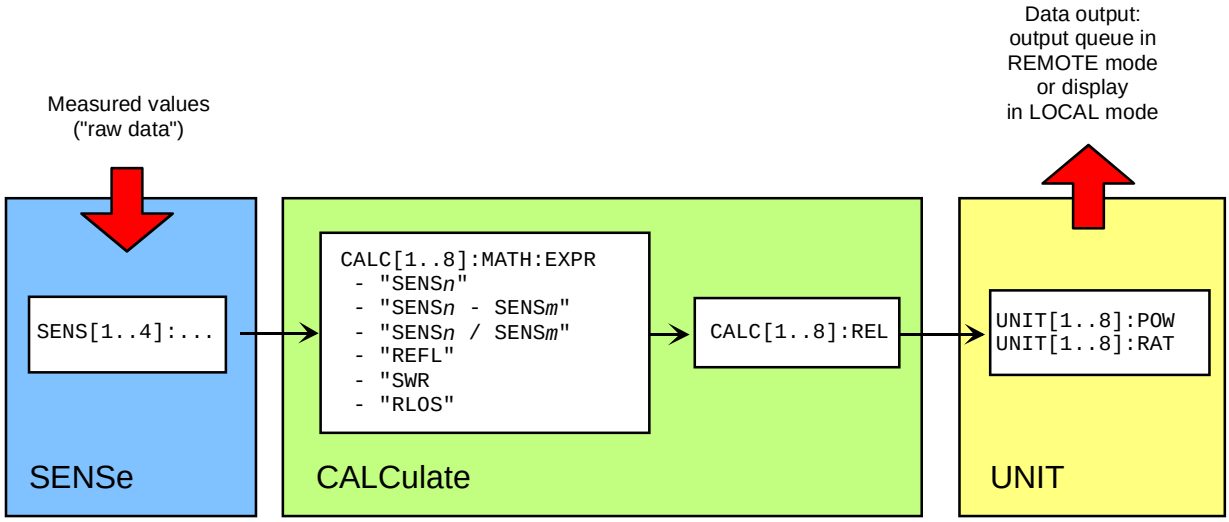

Fig. I-2: Processing of measured values in the R&S NRP

Note: *The high-level commands and the SENSe block allow indices to be specified. These indices refer to the connected sensors (indices 1 to 4) for the SENSe commands whereas the indices of the high-level commands select the CALCulate blocks (indices 1 to 8). Depending on the configuration of the first CALCulate block, `FETCh?` (same meaning as `FETCh1?`) may not deliver the measured value of sensor 1 in contrast to the above examples. After `*RST`, the first CALCulate block delivers the measured value of sensor 1 (`CALC1:MATH "(SENS1)"`) and the second one the measured value of sensor 2, etc. (see command `SYSTem:PRESet`).*

Measuring with low-level commands

Low-level commands allow the user to perform the most important modifications on the measurement configuration. In the present context, low-level commands are all commands that do not belong to high-level commands. These are in particular the commands of the SENSe, TRIGger and CALCulate systems. Since the high-level commands combine different low-level commands, they allow a simpler configuration of measurements.

Each measurement configuration should begin with the *RST command, which sets the R&S NRP to a defined output state. The accurate settings are described in the documentation of remote control command SYSTem:PRESet. The most important settings are listed below:

- Continuous measurements are stopped (INIT:CONT OFF)
- Offset correction are deactivated (SENSe:CORRection:OFFSet:STATe OFF, SENSe:CORRection:DCYCle:STATe OFF, SENSe:CORRection:FDOFfset:STATe OFF).
- All other settings of the SENSe system depend on the sensor used and are specified in the corresponding manual.
- The first 4 CALCulate blocks are set to sensors 1 to 4 (CALCulate*n*:MATH "(SENS*n*)").
- The values are measured as absolute values (CALulate:RELative:STATe OFF).
- Logarithmic units are used (UNIT:POWer dBm and UNIT:RATio dB).

The simplest measurement

The fastest way to obtain a result is to use the following sequence of commands

```
*RST
INIT
FETCh?
```

Normally, *RST will set the ContAv mode. The concept of smart-sensor technology provides that each sensor determines the reset values of the assigned SENSe and TRIGger block. Thus, another mode than ContAv may come after *RST with future sensors. Information is provided in the operating manual of the sensor used.

INIT initiates the measurement. After *RST, the trigger system is set to "straight through" (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.

Configuration of the trigger system

Trigger source

After a measurement is started with INIT, the state WAIT_FOR_TRG is entered. This is a preliminary stage to the measurement, which has been initiated so that the measurement may start with high accuracy at a defined point in time. For this purpose, different sources can be defined for the trigger event, which triggers the measurement. In manual operation, a trigger event is not expected in the ContAv mode. Since the measurement is to be performed continuously, the trigger source (TRIGger:SOURce) is set to IMMediate.

If triggering needs to occur in response to a rising signal edge, the trigger system has to be configured with TRIG:SOUR INT and TRIG:SLOP POS:

```
*RST
TRIG:SOUR INT  (triggering in response to a signal edge)
TRIG:SLOP POS  (triggering in response to a rising signal edge)
INIT
FETCh?
```

Note: *The settings of commands TRIG:SOUR and TRIG:SLOP are ignored in the BurstAv mode. In this mode the beginning and the end of the power pulse are automatically recognized. For this reason, the instrument always triggers INTernal even if TRIG:SOUR has a different setting.*

If a trigger signal is to be routed to the instrument rear panel via the external trigger connector, the trigger source has to be configured with TRIG:SOUR EXT.

```
*RST
TRIG:SOUR EXT  (triggering in response to the edge of an external signal)
TRIG:SLOP POS  (triggering in response to a rising signal edge)
INIT
FETCh?
```

TRIG:SOUR BUS can be set if measurements are to be started with *TRG or GET. This procedure is provided by standard IEEE 488.2, which stipulates that *TRG or GET can also be used to perform complete measurements. This includes the generation of an answer, the measurement result. In the R&S NRP, *TRG does not have this meaning: *TRG only executes a trigger event and thus only causes the status transitions from WAIT_FOR_TRG to MEASURING. *TRG delivers no measurement result and has no effect if TRIG:SOUR is not set to BUS or if the instrument is not in the state WAIT_FOR_TRG. The latter situation applies, for example, if the R&S NRP is IDLE, i.e. INIT:CONT ON is not set nor was INIT executed.

Hint: *Do not use the *TRG command unless unavoidable. Use instead the sequence of commands *RST;INIT;FETCh? or the high-level command MEAS? as the basic structure when programming measurements.*

Delay, holdoff and exclude

Normally, the measurement immediately starts after the trigger event has been executed. This may not be desirable if the measurement is to be started before or after the trigger point. The start of the measurement with reference to the trigger point can be offset using the TRIG:DEL command. A negative sign means that the measurement begins before the trigger point. This is possible because the sensors store sampling values for a while and can use past values when the measurement is started. The command is also used when overshoots are to be ignored at the beginning of a power pulse.

Example:

```
*RST
TRIG:SOUR INT
TRIG:DEL 50 us      (starts measurement 50 µs after the trigger event)
TRIG:HOLD 800 us    (starts next trigger event 800 µs after the trigger event at the earliest)
INIT
FETCh?
```

Another way to modify the trigger system timing is to set a holdoff time (TRIG:HOLD). After a trigger event, all following trigger events are ignored if they occur within the holdoff time. This is to prevent signal components that have not yet decayed from causin triggering by mistake after the measurement has been completed. This makes sense especially with internal triggering (BurstAv mode).

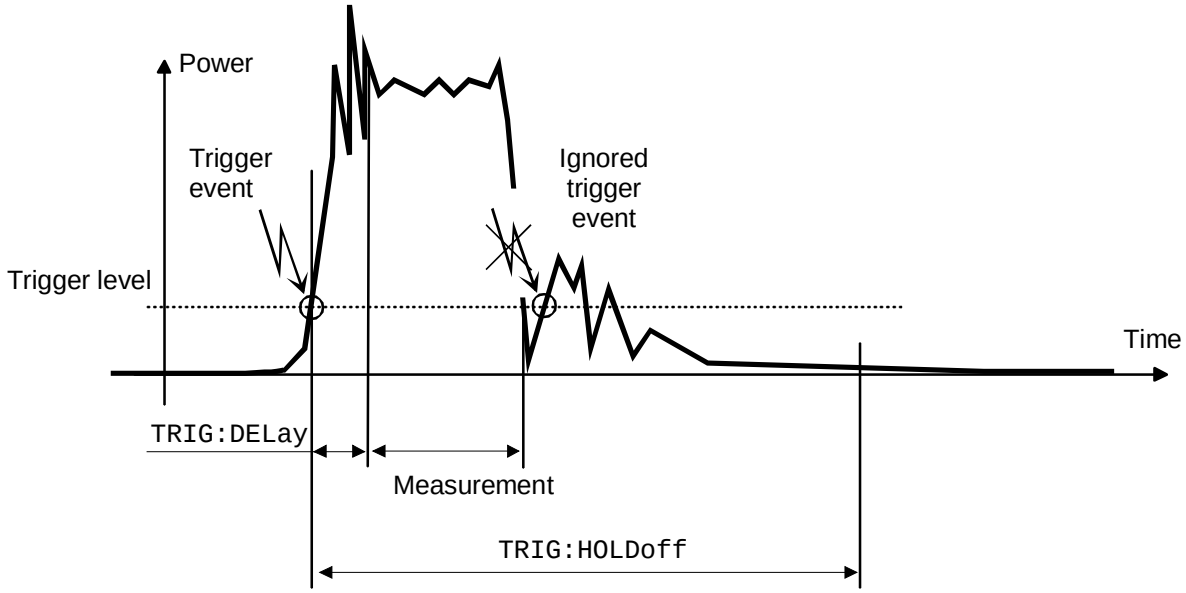

Fig. I-3: Meaning of settings for TRIG:HOLD and TRIG:DEL

It is also possible to exclude time domains from the integration of the measured value at the beginning and the end of the measurement (SENS:TIM:EXCL:STARt and SENS:TIM:EXCL:STOP):

Example:

```
*RST
SENS:FUNC "POW:BURS:AVG"
SENS:TIM:EXCL:STAR 10 US   (ignores 10 µs at the beginning of the measurement)
SENS:TIM:EXCL:STOP 10 US   (ignores 10 µs at the end of the measurement)
INIT
FETCh?
```

Level, hysteresis and dropout time

With internal and external triggering (`TRIG:SOUR INT | EXT`), a trigger event is recognized when the level of a trigger signal exceeds a specific value. This value is the trigger level and can be set with `TRIG:LEV`. With internal triggering, the end of the measurement is recognized when the power level falls below the trigger level. This is not desirable with modulated signals or short interruptions and also when the level just falls slightly below the trigger level:

- `SENS:BURS:DTOL` is used to define a time span during which the power to be measured in the BurstAv mode must remain below the trigger level so that the end of the burst can be detected.
- `TRIG:HYST` is used to specify a value in dB by which the signal must fall below the trigger level so that the end of a burst can be detected.

Configuration of sensor settings

The sensor settings are controlled by the SENSe command system. The sensors tell the basic unit which commands they understand and which parameters are allowed. As a result, the commands described below cannot be used for some sensors.

Selecting a measurement mode

The most important sensor-dependent setting is the selection of a measurement mode:

- **ContAv mode** (`SENS:FUNC "POW:AVG"`): Continuous measurement with only one integration time specified (`SENS:APER`), within which the power is integrated as a measurement result.

  Example:
  ```
  *RST
  SENS:FUNC "POW:AVG"
  SENS:APER 10 MS
  INIT
  FETCh?
  ```

- **Timeslot mode** (`SENS:FUNC "POW:TSL:AVG"`): After the trigger event, the power is measured in timeslots, the number of which is defined with `SENS:TSL:COUN`. The length of the timeslots is set with `SENS:TSL:WIDT`.

  Example:
  ```
  *RST
  SENS:FUNC "POW:TSL:AVG"
  SENS:TSL:WIDT 577 US
  SENS:TSL:COUN 8
  TRIG:SOUR EXT
  INIT
  FETCh?
  ```

- **BurstAv mode** (`SENS:FUNC "POW:BURS:AVG"`): Measurement of power pulses (bursts) with automatic detection of the beginning and end of pulses. The trigger source setting is ignored. As described above, the conditions for the detection of the pulse end can be set with commands `SENS:BURS:DTOL` and `TRIG:HYST`.

  Example:
  ```
  *RST
  SENS:FUNC "POW:BURS:AVG"
  SENS:BURS:DTOL 100 MS
  TRIG:HYST 3 DB
  INIT
  FETCh?
  ```

- **Scope mode** (`SENS:FUNC "XTIM:POW"`): This mode is used to determine a large number of measured values in succession. The number of required measured values is set with `SENS:SWE:POI` and the total measurement time with `SENS:SWE:TIM`. Note that each measurement must be triggered separately. This point is a difference between the Scope mode and the Timeslot mode, in which it is only necessary to start the measurement for measuring the power in all timeslots.

  Example:
  ```
  *RST
  SENS:FUNC "XTIM:POW"
  SENS:SWE:POIN 256
  SENS:SWE:TIM 600 us
  TRIG:COUN 256     (change to IDLE state after the 256th measurement)
  INIT
  FETCh?
  ```

Averaging/filters

The power values to be measured are sampled by the sensors. The sampling values then undergo two-stage filtering before they are made available as measured values.

The first filter stage is a time integration. The integration time is either set explicitly (ContAv mode: `SENS:APER`, Timeslot mode: `SENS:TSL:WIDT` and Scope mode: `SENS:SWE:POIN` and `-:TIME`) or determined automatically (BurstAv mode).

Filtering (averaging) is the second filter stage, which is configured via the command path `SENS:AVERage`. These settings are used to obtain a stable (noise-free) result up to a required accuracy. This is done by means of a digital filter, which has a variable length: the longer the filter, the more stable the result.

- **Manual filter setting:** The filter-length automatic mode is deactivated and the filter length is set in power-of-two numbers.

  Example:
  ```
  *RST
  SENS:AVER:STAT ON           (activates filtering)
  SENS:AVER:COUN:AUTO OFF     (switches off filter-length automatic mode)
  SENS:AVER:COUN 4            (permanently sets filter length to 4 = 2^2)
  INIT
  FETCh?
  ```

Automatic filter setting: SENS:AVER:COUN:AUTO:TYPE NSR | RES is used to select whether the noise component should remain below a specific threshold (NSR) or the measurement result should be stable up to a specific accuracy (RES). To avoid long measurement times, SENS:AVER:COUNT:AUTO:MTIM can be used to specify a maximum measurement time. The maximum filter length is set such that the measurements do not exceed this time, even if the desired stability has not yet been obtained.

Example:

```
*RST
SENS:AVER:STAT ON                  (activates filtering)
SENS:AVER:COUN:AUTO ON             (switches on filter-length automatic mode)
SENS:AVER:COUN:AUTO:TYPE RES       (sets automatic mode to RESolution)
SENS:AVER:COUN:AUTO:RES 3          (maintains 3 places noise-free in the result)
INIT
FETCh?
```

Example:

```
*RST
SENS:AVER:STAT ON                  (activates filtering)
SENS:AVER:COUN:AUTO ON             (switches on filter-length automatic mode)
SENS:AVER:COUN:AUTO:TYPE NSR       (sets automatic mode to NSRatio)
SENS:AVER:COUN:AUTO:NSR 0.01 DB    (maximum noise component in the result)
SENS:AVER:COUN:AUTO:MTIM 10 S      (but does not measure more than 10 s)
INIT
FETCh?
```

All intermediate pushed values delivered by the first filter stage are stored in the filter. The earliest measured value is ousted out of the filter, since the filter has only a limited length. SENS:AVER:TCON MOV | REP is used to set when the filter algorithm is to be applied to the filter. With the setting MOVing, a new measure value is calculated for each new intermediate measured value. This is the default setting in the LOCAL mode. SENS:AVER:TCON REPeat is set in the REMOTE mode. In this particular case, new measured values are calculated when all intermediate measured values have been replaced by new ones.

Note: *Changing from SENS:AVER:TCON MOV to REP in the LOCAL-REMOTE transition causes the update rate of measured values to be reduced, since the filter must be completely filled for each new measured value.*

Measured-value corrections

The R&S NRP offers different options for correcting measured values in the instrument. These options all require an existing knowledge of the test setup or the time structure of the signal. Offsets in the result can be corrected globally and depending on the frequency, and it is possible to consider the duty cycle of a signal and the influence of the complex reflection coefficient (Γ) of the power source.

- **Global offset correction**: All measured values are multiplied by a correction factor (logarithmically added).

  Example:
  ```
  *RST
  SENS:CORR:OFFS:STAT ON     (global offset correction ON)
  SENS:CORR:OFFS 20 DB       (corrects result by +20 dB)
  INIT
  FETCh?
  ```

- **Frequency-dependent offset correction**: Two-column tables can be entered in which frequencies and correction values can be stored. A frequency-dependent correction value is determined by linear interpolation in the units Hz and dB using the signal frequency (defined with SENS:FREQ). The interpolated correction value can be queried with SENS:FDOF? for checking purposes.

  Example:
  ```
  *RST
  MEM:TABL:MOVE "Table 1" "Splitter"    (renames first table)
  MEM:TABL:SEL "Splitter"               (selects table)
  MEM:TABL:CLEar                        (deletes selected table)
  MEM:TABL:FREQ   0,1e4,5e4,1e5,1e9     (interpolation points on the frequency axis)
  MEM:TABL:GAIN 3.1,3.1,3.0,2.9,2.9     (associated offset values)
  SENS:FREQ 900 MHZ                     (signal frequency)
  SENS:CORR:FDOT:STAT ON                (activates frequency-dependent offset correction)
  SENS:CORR:FDOT "Splitter"             (selects an offset table)
  SENS:CORR:FDOF?                       (queries correction value used)
  INIT
  FETCh?
  ```

  This example assumes that a table called "Table 1" is available.

- **Duty cycle**: If the duty cycle of a pulsed signal (SENS:DCYC) is reported to the R&S NRP, the R&S NRP delivers the average power in the pulse.

  Example:
  ```
  *RST
  SENS:CORR:DCYC:STAT ON     (duty-cycle correction ON)
  SENS:CORR:DCYC 30 PCT      (duty cycle of 30%)
  INIT
  FETCh?
  ```

- **Reflection coefficient of the source (source gamma, Γ)**: Reflections at the power source may distort the result. If the reflection coefficient of the source is known, it can be specified for the measured-value correction via command path SENS:SGAM.

  Example:
  ```
  *RST
  SENS:SGAM:CORR:STAT ON      (considers the reflection coefficient Γ of the source)
  SENS:SGAM:MAGN 0.01         (magnitude of Γ)
  SENS:SGAM:PHAS 179          (phase angle of Γ)
  INIT
  FETCh?
  ```

Configuration of CALCulate blocks

The function of the CALCulate blocks has already been explained. Its most important task is the calculation and provision of measurement results.

Calculation function and relative measurement

The calculation functions mentioned in connection with high-level commands are internally implemented via commands CALC:MATH and CALC:REL:STAT.

Keyword for selecting a calculation function with high-level commands		Corresponding low-level commands (n,m=1,2,3,4)
:DIFF	(Difference)	CALC:MATH "(SENSn-SENSm)"; REL:STAT OFF
:DIFF:REL	(Difference with reference value)	CALC:MATH "(SENSn-SENSm)"; REL:STAT ON
:RAT	(Ratio)	CALC:MATH "(SENSn/SENSm)"; REL:STAT OFF
:RAT:REL	(Ratio with reference value)	CALC:MATH "(SENSn/SENSm)"; REL:STAT ON
:SWR	(Standing wave ratio)	CALC:MATH "SWR(SENSn)"; REL:STAT OFF
:RLOS	(Return loss)	CALC:MATH "RLOS(SENSn)"; REL:STAT OFF
:REFL	(Reflection coefficient)	CALC:MATH "REFL(SENSn)"; REL:STAT OFF

Example:
```
*RST
CALC:MATH "(SENS1/SENS2)"     (processes sensors 1 and 2)
CALC:REL:STAT ON              (relative measurement)
CALC:REL 23 dB                (sets reference value)
INIT:ALL                      (starts measurements on all sensors)
FETCh?
```

Optimization of measurement speed

The measurement time can be optimized by performing the following settings:

```
SYST:SPEed FAST             (deactivates screen content)
SENS:AVER:STAT OFF          (deactivates filtering of measured values)
SENS:FUNC "POW:AVG"         (ContAv mode)
SENS:BUFF:STAT OFF          (no buffered measurements)
SENS:APER MIN               (integration time as short as possible)
SENS:RANG:AUTO OFF          (automatic range selection OFF)
SENS:CORR:OFFS:STAT OFF     (no global offset correction)
SENS:CORR:DCYC:STAT OFF     (no duty cycle correction)
SENS:CORR:FDOT:STAT OFF     (no frequency-dependent offset correction)
SENS:SGAM:CORR:STAT OFF     (no measured-value correction for reflection coefficient of source)
TRIG:DEL 0                  (no delay on triggering)
TRIG:DEL:AUTO OFF           (no delay on triggering)
CALC1:MATH "(SENS1)"        (only uses the first CALCulate block)
CALC2:MATH "(SENS2)"
CALC3:MATH "(SENS2)"
CALC4:MATH "(SENS2)"
CALC5:MATH "(SENS2)"
CALC6:MATH "(SENS2)"
CALC7:MATH "(SENS2)"
CALC8:MATH "(SENS2)"
```

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8 Maintenance

Under normal operating conditions the R&S NRP does not require any regular maintenance except for occasional cleaning of the front panel.

Sensor test

The sensor selftest is described in Chapter 4 in the section "Selftest".

Instrument selftest

The R&S NRP carries out a selftest during booting. This selftest is described in Chapter 1 in the section titled "Welcome screen and function test".

Cleaning the exterior

To clean the exterior, use a soft, lintfree cloth and an alcohol-free solvent, e.g. a commercially available dishwashing liquid.

Storage

The R&S NRP has a storage temperature range of –20 °C to +70 °C.

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9 SCPI Error Messages

The list below contains all error messages that may occur in the instrument. Negative error numbers are defined in the SCPI standard, positive error numbers identify device-specific errors.

The left column of the following table gives the error code. In the right column, the text of the error message displayed or entered in the error/event queue is printed in bold. An additional explanation is given below this text.

SCPI-Specific Error Messages

No error

Error code	Error text returned upon queue query Explanations
0	**No error** This message is displayed if the error queue is empty.

Command Error

Command errors; causes bit 5 in the ESR to be set.

Error code	Error text returned upon queue query Explanations
-100	**Command error** Command faulty or invalid.
-101	**Invalid character** The command contains a character which is invalid for that type.
-102	**Syntax error** The command is invalid.
-103	**Invalid separator** Command contains an illegal character where a separator is expected.
-104	**Data type error** Command contains an invalid data element.
-108	**Parameter not allowed** The command contains too many parameters.
-109	**Missing parameter** The command contains fewer parameters than required.
-111	**Header separator error** The header contains an illegal delimiter.

Error code	Error text returned upon queue query Explanations
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is not defined for the device.
-114	**Header suffix out of range** The header contains an illegal numeric suffix.
-120	**Numeric data error** The command contains a faulty numeric parameter.
-121	**Invalid character in number** A numeric contains an invalid character.
-123	**Exponent too large** The magnitude of the exponent is larger than 32000.
-124	**Too many digits** The numeric contains too many digits.
-127	**Invalid numeric data**
-128	**Numeric data not allowed** The command contains a numeric data element in a position where it is not accepted.
-131	**Invalid suffix** The suffix is invalid for this device. The suffix is the index that indexes the sensor with the SENSe commands (1-4), the CALCulate block with the high-level measurement commands (1-4) and the window with the DISPlay commands (1-4).
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this position in the command.
-141	**Invalid character data** Either the character data element contains an invalid character or the particular element received is not valid for this command.
-144	**Character data too long** The character data element contains too many characters.
-148	**Character data not allowed** The character data element used is not allowed for this command or at this position of the command.
-151	**Invalid string data** The command contains invalid string data.
-158	**String data not allowed** The command contains a valid string data element at a position where it is not allowed.
-161	**Invalid block data** The command contains invalid block data.
-168	**Block data not allowed** The command contains a legal block data element at a point where it is not allowed.

Error code	Error text returned upon queue query Explanations
-171	**Invalid expression** The command contains an invalid mathematical expression data element.
-178	**Expression data not allowed** The command contains mathematical expression data at a point where they are not allowed.

Execution Error

Execution errors; cause bit 4 in the ESR register to be set

Error code	Error text returned upon queue query Explanations
-200	**Execution error** An error occurred upon command execution.
-203	**Command protected** An attempt was made to execute a protected command.
-210	**Trigger error** Error on triggering the device.
-211	**Trigger ignored** A *TRG or a triggering signal was ignored.
-213	**Init ignored** A request for a measurement initialization was ignored as another measurement was already in progress.
-214	**Trigger deadlock** A measurement could not be started or a result query could not be processed since the device would otherwise enter a deadlock state. This occurs under the following conditions: (1) `TRIG:SOUR BUS;:INIT;:FETCh?`: A `*TRG` or `TRIG:IMM` would be required for triggering but these commands cannot be executed since `FETCh?` blocks the entry. But `FETCh?` waits until the measured values are available. (2) `FETCh?` was called but no valid result was available and the trigger system of the sensor is `IDLE`. `FETCh?` blocks the entry so that a measurement cannot be started with `INIT` either.
-220	**Parameter error** The command contains a faulty or invalid parameter.
-221	**Settings conflict** There is a setting conflict between two or more parameters.
-222	**Data out of range** A program data element is outside the legal range as defined by the device.
-223	**Too much data** A valid parameter is received but it contains more data than the device can handle.
-224	**Illegal parameter value** The parameter value is invalid.

Error code	Error text returned upon queue query Explanations
-225	**Out of memory** The device has insufficient memory to perform the required operation.
-226	**Lists not same length** A list of offset values and frequencies has not the same length as an associated list of frequency and offset values.
-230	**Data corrupt or stale** The data are incomplete or invalid.
-240	**Hardware error** The command cannot be executed because of a hardware problem in the device.
-241	**Hardware missing** The command cannot be executed because of missing device hardware.

Device-Specific Errors

Device-specific error; causes bit 5 to be set in the ESR register

Error code	Error text returned upon queue query Explanations
-300	**Device-specific error** Generic device-dependent error that cannot be defined more precisely.
-310	**System error** Indicates that some system error has occurred. Please contact the R&S service center.
-311	**Memory error** An error was detected in the device's memory.
-314	**Save/recall memory lost** Indicates that the nonvolatile data saved by the *SAV? command has been lost.
-315	**Configuration memory lost** Indicates that nonvolatile configuration data saved by the device has been lost.
-330	**Self-test failed** The self-test could not be executed.
-341	**Zeroing failed** The zeroing of a sensor (`CALibration:ZERO:AUTO ONCE`) has failed. The most frequent cause for this error is a signal that is applied to the sensor input and prevents zeroing.
-350	**Queue overflow** This code is entered into the queue in lieu of the code that caused the error. It indicates that an error occurred but was not recorded. Five entries are accepted in the queue.
-363	**Input buffer overrun** More commands were sent to the device than can be simultaneously executed or stored.

Query Errors

Query errors; cause bit 2 in the ESR register to be set

Error code	Error text returned upon queue query Explanations
-400	**Query error** Generic query error that cannot be defined more precisely.
-410	**Query INTERRUPTED** The query was interrupted. Example: The query is followed by new data before the response was completely sent.
-420	**Query UNTERMINATED** An incomplete query was received.
-430	**Query DEADLOCKED** The query cannot be processed.
-440	**Query UNTERMINATED after indefinite response** A query is received in the same program message after a query requesting an indefinite response.

Device-Dependent Errors

Device-dependent error; causes bit 5 to be set in the ESR register

Error code	Error text returned upon queue query Explanations
1	**Device-dependent error** This error message is sent when the device cannot detect a more specific error.
2	**IEEE 1174 error (unknown emulation code)** An invalid IEEE-1174 emulation mode was selected for the Ethernet link.
22	**IEEE1174 mode 488.1 not allowed** Setting the IEEE 1174.1 mode is not permissible.
24	**Sensor mode not supported** An attempt was made to set the sensor to a measurement mode which is not supported.
25	**Not supported** A command is not supported (by the sensor).
26	**State not supported** Attempt was made to set an invalid value. The permissible values for sensor-dependent commands can be declared as impermissible by a sensor depending on the context.
27	**Sensor not present** A command could not be executed because the required sensor is not connected.

Error code	Error text returned upon queue query Explanations
28	**Sensor not idle** A command could not be executed because the respective sensor was not in the IDLE state at that time.
29	**Measurement aborted while waiting for data** A measurement was aborted while the device was waiting for measurement results.
30	**No extremes available in this mode** Extreme values (minimum, maximum und peak-to-peak values) are not calculated in the set measurement mode.
39	**Sensor removed while waiting for result** A sensor was disconnected while the device was waiting for measurement results.
42	**Failed to initialize sensor** A sensor could not be initialized.
43	**Error in receiving calibration data from sensor** An error occurred in receiving calibration data from the sensor (command `CALibration[1..4]:DATA?`).
44	**Error in sending calibration data to sensor** An error occurred in sending calibration data to the sensor (command `CALibration[1..4]:DATA <block_data>`).
45	**Command not supported by sensor** Attempt was made to send a command to a sensor that does not support this command. This may depend on the current sensor status. The sensors can inform the R&S NRP at any point which commands they support or do not support. This mainly concerns commands of the Sense and Trigger systems.
46	**Sensor failure: no command receipt** A sensor did not acknowledge any command.
47	**Error in receiving battery data** An error occurred in receiving battery data (command `SYSTem:BATTery:STATus?`).
48	**Error in sending battery data** An error occurred in sending battery data (command `SYSTem:BATTery:MODE <block_data>`).
50	**Fatal sensor error** A sensor signalled a serious error. If the problem persists, please contact the R&S servicing center.
51	**Overload** A sensor signalled that the signal applied has exceeded the permissible maximum power. CAUTION! Sensor overload can destroy the electronic measurement system.
52	**Overrange** This error is signalled if a sensor detects that one of its measurement channels is overranged. The result is then probably incorrect. This error can occur if the automatic range function is deactivated (`SENSe:RANGe:AUTO OFF`) and the manually selected measurement channel is not suitable or the cross-over level (`SENSe:RANGe:AUTO:CLEVel`) was incorrectly selected.
53	**Truncated measurement** In the BurstAv mode, the samples for the power are stored in an internal buffer until the end of the power pulse is detected. If the buffer overflows the measurement is terminated and error 53 "Truncated measurement" is generated.

Error code	**Error text returned upon queue query** Explanations
54	**Sample error** Samples were lost while sampling the signal applied. The measured value can thus be incorrect.
55	**Sensor hardware error** A sensor signalled an error in the sensor hardware. If the problem persists, please contact the R&S servicing center.
56	**Filter truncated** With the automatic filter function activated, a sensor tries to set the filter length such that the required accuracy is obtained. If the measurement time required for this exceeds the value set with `SENSe:AVERage:COUNt:AUTO:MTIMe` (max. time), the filter length is shortened such that a measurement does not last more than the max. time and error message 56 "Filter truncated" is generated.