Application Note

# USING R&S POWER SENSORS WITH R&S SIGNAL GENERATORS

## Products:

- R&S®NRP-Zxx
- R&S®NRPxxS/A/T(N)
- R&S®NRPxxP(N)
- R&S®NRQ6
- R&S®SMW200A
- R&S®SMM100A
- R&S®SMA100B
- R&S®SMB100B
- R&S®SMBV100B
- R&S®SMCV100B

Bernhard Reifert | 1GP141 | Version 2 | 10.2023

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# Contents

# 1 Overview

This application note addresses the diverse possibilities of interoperability between Rohde & Schwarz power sensors and Rohde & Schwarz signal generators. All current and many legacy Rohde & Schwarz signal generators offer the capability of directly connecting power sensors. This enables power measurements without the need of a base unit or separate PC to display the readings. Furthermore, sensors can be used for special tasks like filling a user correction table or continuously controlling levels at crucial points in the measurement configuration.

By means of an additional power sensor the level accuracy at the generators output power at any point in the measurement setup can be significantly improved.

The generators support up to four power sensors simultaneously. Depending on the sensor and generator type, the connection is made via a separate sensor connector or via USB or LAN.

# 2 Supported Devices

## 2.1 Signal Generators

This application note applies to the following signal generators, assuming they are equipped with a firmware version 5.20 or higher:

- ► R&S®SMW200A vector signal generator, referred as SMW200A
- ► R&S®SMM100A vector signal generator, referred as SMM100A
- ► R&S®SMA100B RF and microwave signal generator, referred as SMA100B
- ► R&S®SMB100B RF signal generator, referred as SMB100B
- ► R&S®SMBV100B vector signal generator, referred as SMBV100B
- ► R&S®SMCV100B vector signal generator, referred as SMCV100B

In addition, the following legacy generators support NRP power sensors connected via sensor connector or USB (the SMB100A also supports LAN in addition):

- ► R&S®SMU200A vector signal generator, referred as SMU200A
- ► R&S®SMA100A RF signal generator, referred as SMA100A
- ► R&S®SMB100A RF and microwave signal generator, referred as SMB100B
- ► R&S®SMBV100A vector signal generator, referred as SMBV100A
- ► R&S®SMC100A RF signal generator, referred as SMC100A
- ► R&S®SMF100A microwave signal generator, referred as SMF100A

The specific capabilities are indicated in Annex B Overview over Generators and their Capabilities.

## 2.2 Power Sensors

In general, every Rohde & Schwarz power sensor which is equipped with a special sensor connector (6-pin ODU mini-snap series B), an USB connector or a LAN connector will be accepted and supported by the generators.

In detail this covers

| Sensor R&S® | Technology |
|---|---|
| **NRP-Z11, -Z21, -Z22, -Z23, -Z24, -Z31, -Z41 and -Z61** | Three path diode universal power sensors |
| **NRP-Z211 and NRP-Z221** | Two path diode universal power sensors |
| **NRP-Z91 and NRP-Z92** | Average power sensors |
| **NRP-Z28 and NRP-Z98** | Level control sensors |
| **NRP-Z51, -Z52, -Z55, -Z56, -Z57 and -Z58** | Thermal power sensors |
| **NRP-Z81, NRP-Z85 and NRP-Z86** | Wideband power sensors |
| **NPR6A(N) and NRP18A(N)** | EMC Average power sensors |
| **NRP18P, NRP40P and NRP50P** | Pulse power sensors |
| **NRP8S until NRP90S(N/V)** | Three path diode universal power sensors |
| **NRP18T(N) until NRP170TWG(N)** | Thermal power sensors |
| **NRQ6** | Frequency selective power sensor |

# 3 Summary of Features

The combination of power sensors and generators offers significant benefits for the overall measurement setup. Without the need of a dedicated NRX/NRP base unit, up to four sensors can be used to simultaneously indicate the power at any point of the measurement setup.

In addition, by means of the power control feature, the RF level at any point of the setup can be stabilized against frequency response, compression artefacts and temperature drifts over time. Moreover, the level uncertainty of the generator is significant improved and shifted to the standard of power sensors.

Sensors can be connected via a dedicated sensor connector, via standard USB or via LAN. This enables sensors to work in any distance to the generator, e.g. on antenna masts, EMC chambers or in distant locations in the organization or test plant.

The following capabilities are provided by combining power sensors and signal generators:

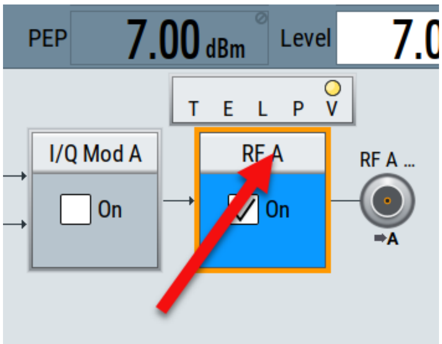
| | |
|---|---|
| NRP Power Viewer | Monitor the results up to four power sensors simultaneously |
| NRP Power Control | Improve the level accuracy by a closed loop power control |
| NRP Power Analysis | Evaluate frequency response, power response, time domain and pulse analysis of test setups (selected generators, see separate documentation) |
| NRP User Correction | Fill level correction tables automatically |
| DME Pulse Detection | Establish a DME test configuration (SMBV100B only, refer to user manual) |

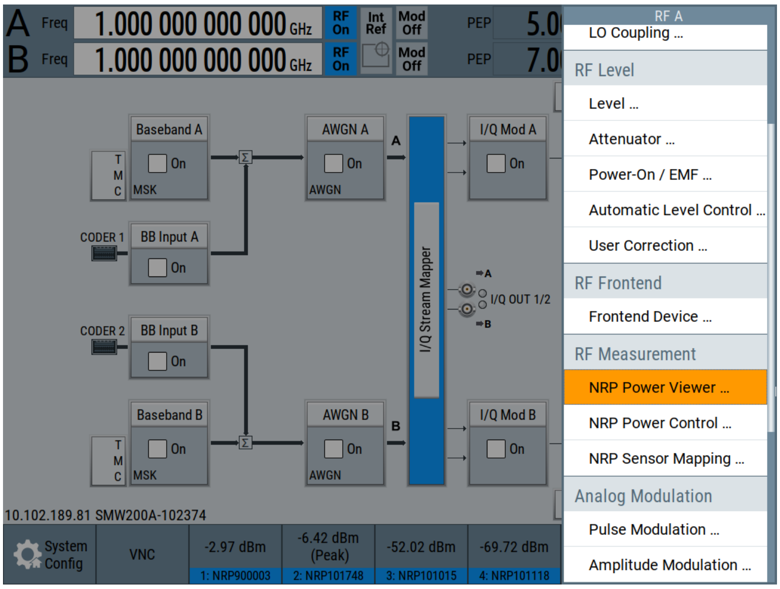
# 4 Accessing RF Measurement Capabilities

Accessing the power sensor dialogs differs slightly between vector signal generators (e.g. SMW200A or SMBV100A), having a block diagram as home screen, and analog signal generators like SMA100B, providing feature tiles.

## 4.1 Instruments with Block Diagram Home Screen

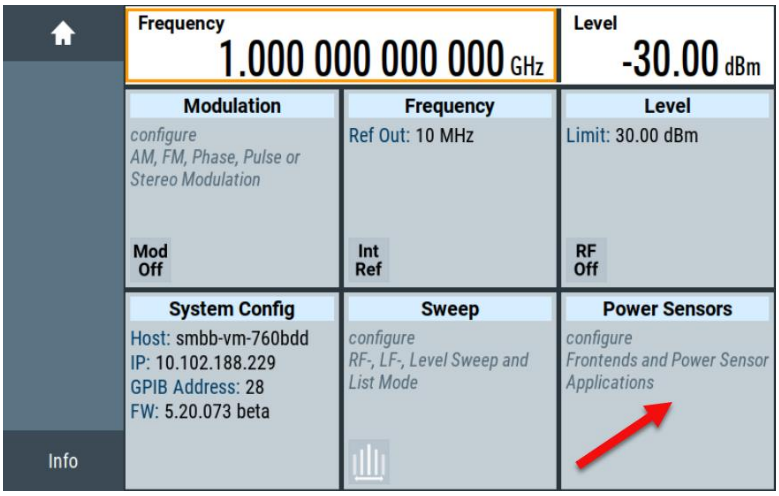
To open the sensor related dialogs, click at the RF block to open the RF menu. Locate *RF Measurement* and open the appropriate settings. Note that on instruments providing multiple RF paths, the dialogs can be opened via each RF block. Nevertheless, the same settings are opened.



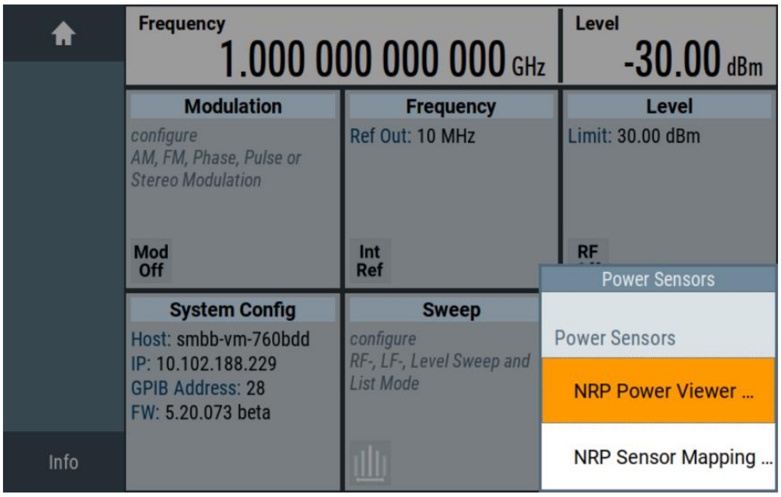



## 4.2 Instruments with Feature Screen

On instruments with feature screen, click the rightmost bottom tile to open the local menu.




Locate Power Sensors and open the corresponding dialog.




Since this tile is used for different external devices (including sensors), its name and content depend on the specific instrument and its capabilities.

# 5 Setting up Sensors

## 5.1 Sensor Mapping

Before a sensor can be accessed by the generator, the sensor must be "mapped". This means, that an index number in the range from 1 to 4 is assigned to the sensor. Later, the sensor is referred by this index. Up to four sensors are supported simultaneously.

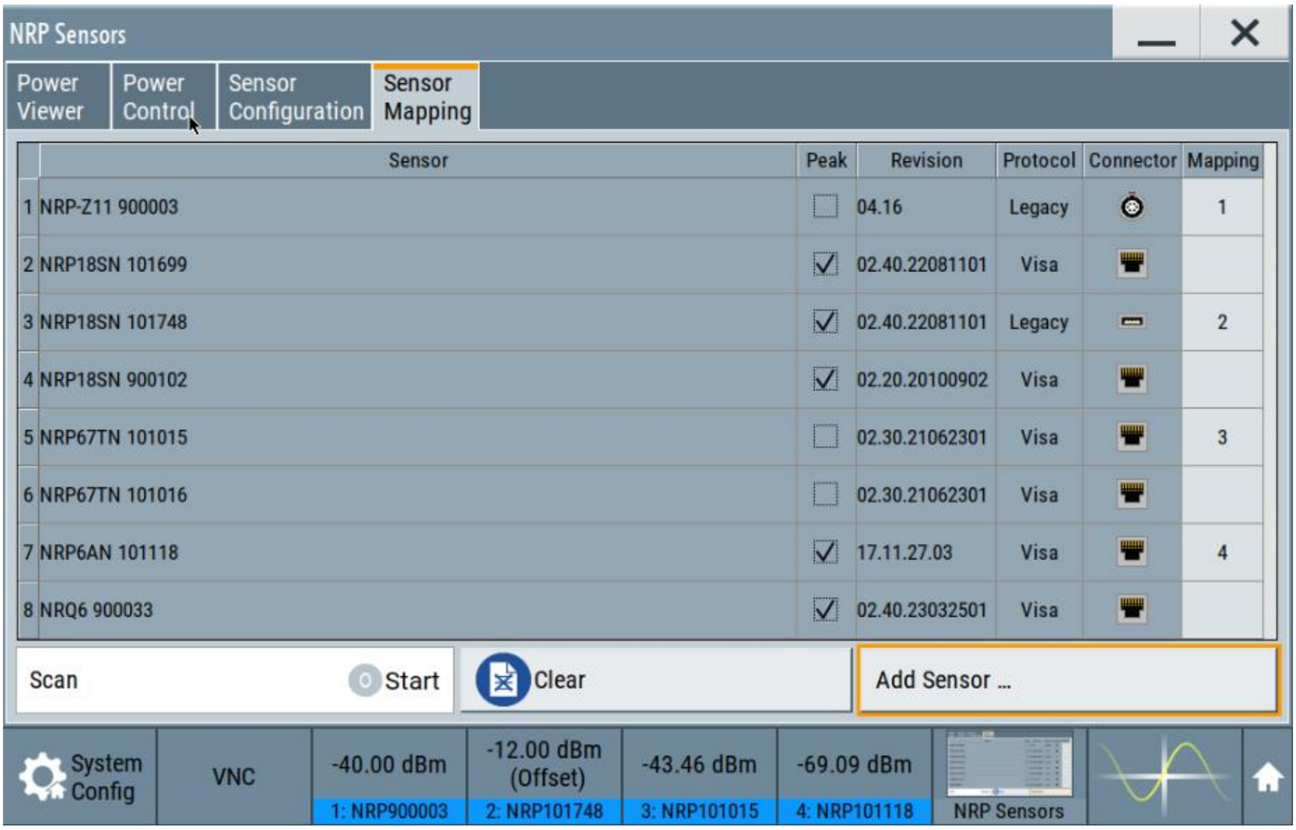
Sensor mapping is performed by the sensor mapping dialog. The available sensors are displayed in the mapping table. Sensors plugged into the sensor connector or USB are automatically added to the table. In addition, they are mapped automatically according to the following rules:

- ► Sensors attached to the sensor connector are assigned to index 1
- ► Sensors connected via USB are assigned to index 2 to 4 according to the sequence of connection
- ► Sensors connected via NRP-Z5 are assigned according to the connector they are attached with

All mappings can be reconfigured manually.

Sensors connected via LAN are neither detected nor mapped automatically. To appear in the mapping table, LAN sensors require a scan sequence or must be added manually, as described below. In addition, an index number must be assigned to the sensor of interest.

The sensor mapping is preserved in case of a shut-down and sensors are remapped after power-on.



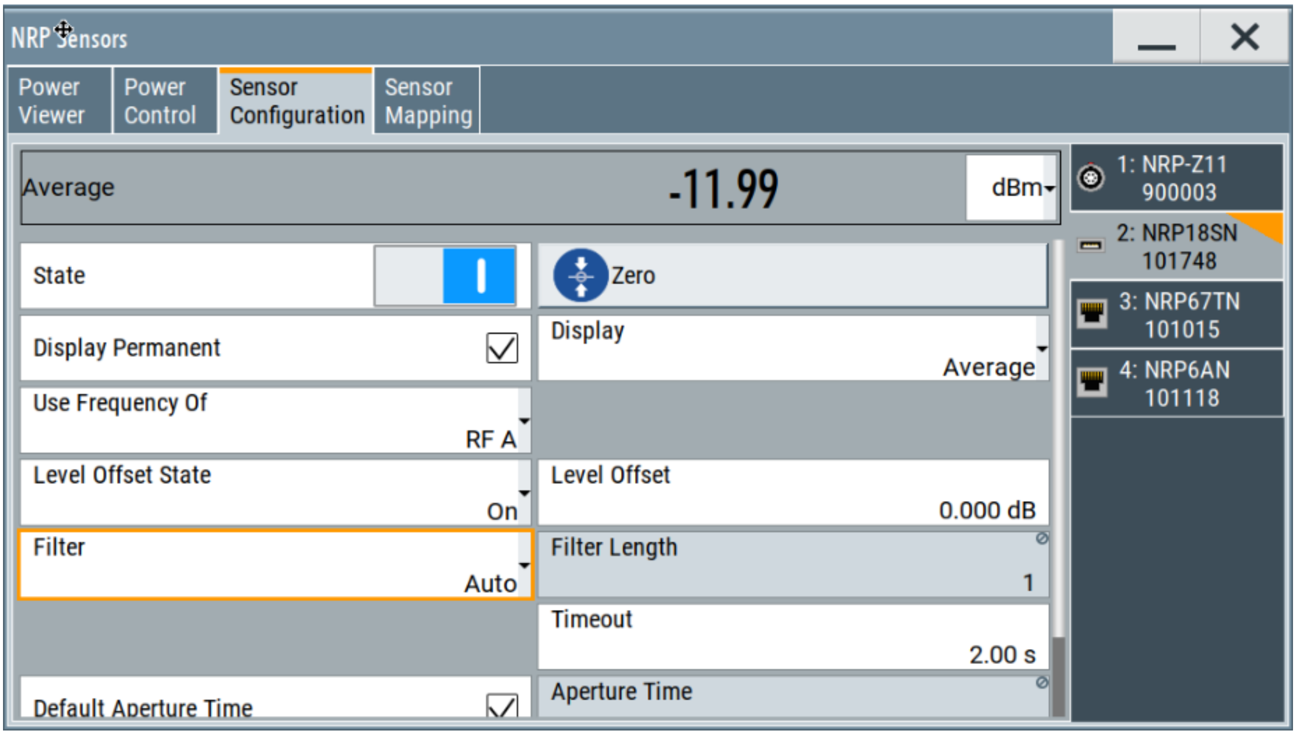

Description on columns / buttons:

- ► **Sensor**
  The sensors are indicated by type and serial number

- **Peak**
  Indicates the capability of providing peak level measurements
- **Revision**
  Firmware revision of the sensors.
- **Protocol**
  Indicates the protocol version provided by the sensor. The NRP-Z series sensors always use legacy protocol. Other series of NRP sensors provide VISA (USBTMC) as well as legacy when plugged into USB or sensor connector. When connected via LAN, VISA protocol is used. The generator automatically chooses the most appropriate protocol.
- **Connector**
  Picture of connector.
- **Mapping**
  Indicates the mapping number of the sensor. This column is editable to assign mapping numbers to the sensors. If a number is already allocated it will be removed from the former sensor.
- **Scan**
  Starts scanning the local subnet for NRP LAN sensors. Sensors found are added to the table, but not mapped yet.
- **Clear**
  Removes LAN sensors from mapping table.
- **Add Sensor …**
  Sensors which are available via LAN but not detected by means of **Scan** can be entered here manually. This typically is required when the sensor of interest is not part of the local subnet or hidden due to the individual network configuration.

## 5.2 Sensor Configuration

By means of the Sensor Configuration dialog, sensors can be configured according to the needs of the measurement task. There is a side tab for each mapped sensor. The configuration is valid for most sensor applications inside the generator, especially for Power Viewer, Power Control and User Correction (UCORR).



- **Side Tabs** (right hand)
  Indicates the type, serial number and connector of the corresponding sensor. Sensors have to be mapped (have an index number assigned, refer to chapter 5.1 Sensor Mapping) in order to be indicated here.

- **Headline**
  Displays the current measurement value of the sensor together with the Average/Peak indicator. By default, the value is updated continuously. When the sensor is used for additional functions, e.g. to be queried by remote or as part of a power control loop, the latest available measurement value is displayed. The value is displayed as average or peak, depending on the capabilities of the sensor and the option chosen in the "Display" setting.

- **State**
  Enables or disables the repetitive measurement and indication of a sensor. If disabled, no measurement value is displayed and the sensor is not queried periodically. If the sensor is part of a power control loop, its state is disabled too. Nevertheless, remote access keeps possible.
  Note that in case of PRESET the state is switched off in order to avoid disturbance of setting times.

- **Display Permanent**
  Enables the permanent view of the measurement results. When enabled, the results are displayed in the task bar in on the left or bottom side of the screen in order to have them visible even if the sensor dialogs are closed or covered.

- **Zero**
  Starts a zeroing sequence of the corresponding sensor. The sensor must be disconnected from RF power in order to measure its own noise level and take it into account.

- **Use Frequency of**
  In order to provide the best available precision the sensor needs to know the main frequency of the measured signal. By default, the generators output frequency is assumed to be the frequency to measure and this is maintained continuously in the sensor (setting RF A, RF B or RF). If this assumption is not valid, e.g. in case of frequency converters, the measurement frequency can be entered manually.

- **Level Offset State**
  Enables or disables the consideration of a level offset value. By means of this setting a level offset can be disregarded without clearing it.

- **Level Offset**
  Value added by the sensor to its raw measurement result. If for example the level at the sensor is -10dBm and the level offset is +30dB, the sensor delivers a result of +20dBm. By means of this value amplifiers and attenuators as well as splitters can be considered making interpretation of measurement results more convenient.

- **Filter**
  In order to denoise results and improve precision, power sensors are equipped with an averaging filter. The filter length should be greater when measuring level values near the lower end of the sensors power range and may be small, e.g. one, when operating at higher levels.

  This setting defines the operation mode of the filter:
  - Auto: The filter length is determined automatically according to the current level.
  - User: The filter length can be set manually.
  - Fixed Noise: The filter length is determined automatically according to the requested noise suppression.

- **Filter length**
  In case of mode Auto the current filter length is displayed. In case of mode User, the filter length can be entered here.

- **Timeout**
  In mode Fixed Noise, this value sets a timeout to the sensor in order to limit the measurement time in

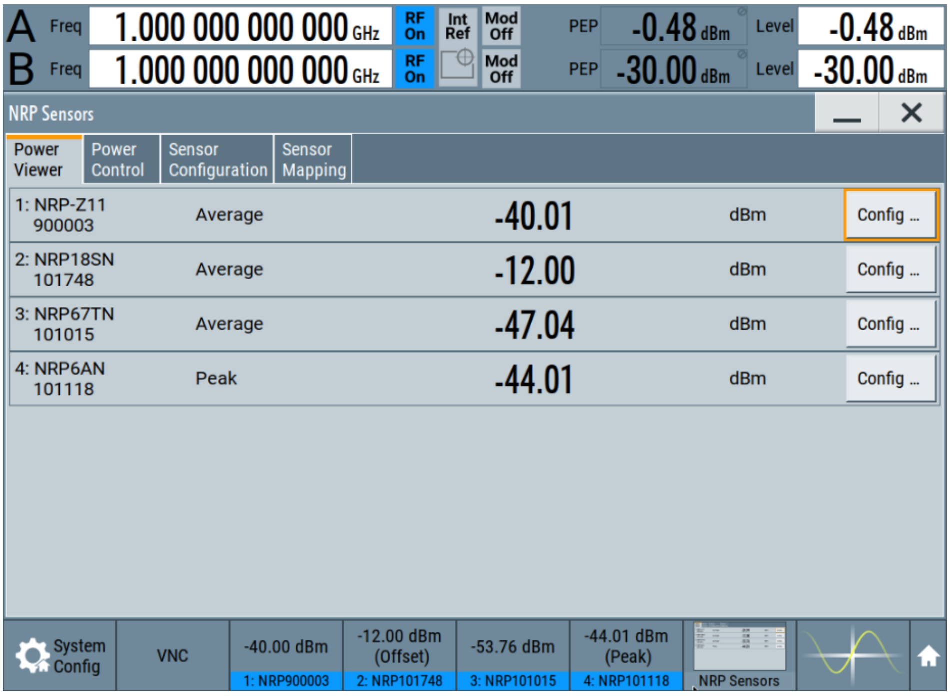
case of small level values. In other modes, this value defines a communication timeout between sensor and generator.

- **Default Aperture Time**
  If set, the sensor is forced to use its default aperture time, not a user defined value.
- **Aperture time**
  Sets the aperture time if the preceding checkbox is unchecked.
- **S-Parameter**
  If an S-parameter set is stored in the power sensor, it can be selected here. By means of S-parameters e.g. the gain or attenuation as well as frequency response of devices in the measurement path can be considered. Measurement values are adjusted accordingly.

# 6 Features in Detail

## 6.1 Power Viewer

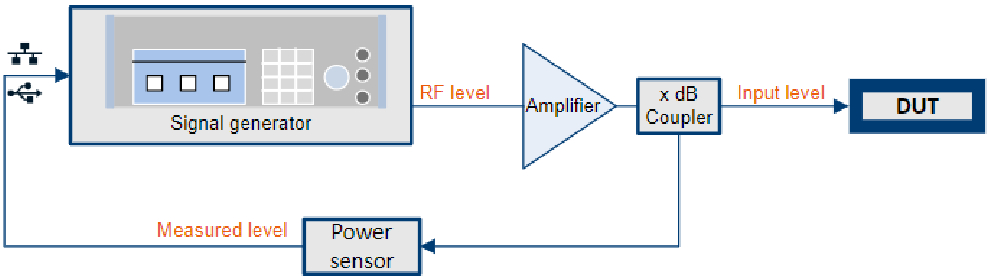
The Power Viewer offers a brief overview of all connected sensors and their current readings. The measurement results are displayed full-screen in a dedicated dialog and optional permanently in the task bar at the bottom or the left side of the screen. The permanent view is intended to monitor measurement values while sensor dialogs are closed or covered by other settings. Permanent view can be enabled for each sensor separately and so can be restricted to values of particular interest.



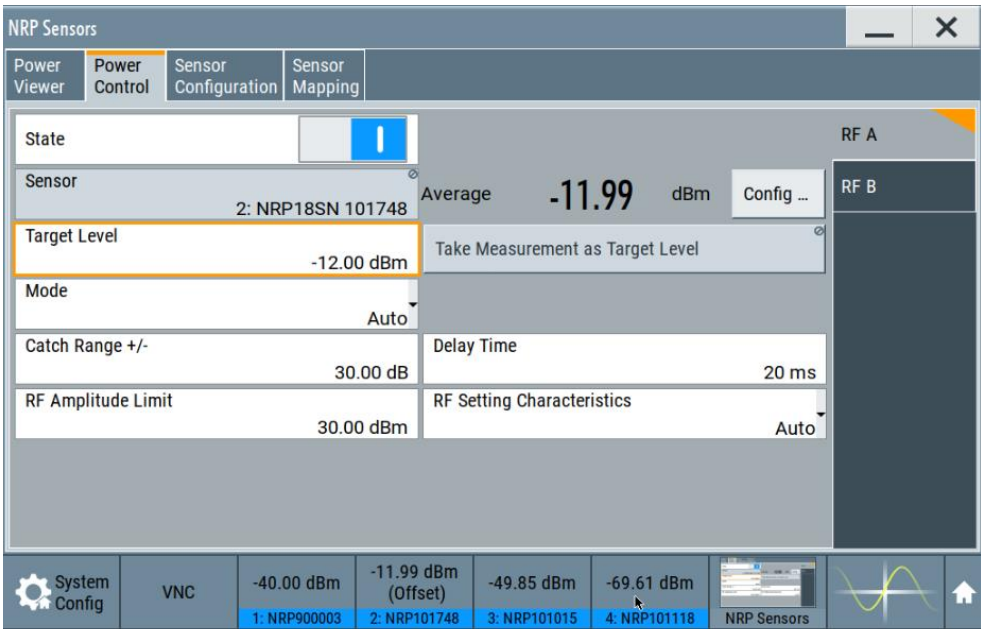

The **Config…** button links to the configuration sheet of the corresponding sensor. Sensors can be enabled and disabled over there, Average and Peek measurement can be selected and permanent view can be activated.

## 6.2 Power Control

The power control feature provides continuous monitoring and adjustment of the RF level at the measurement point of the sensor.




When enabling power control, a control loop is established to stabilize the RF power at a specific point in the measurement setup. The generator continuously or on demand queries the selected power sensor and adjusts the output power to minimize the difference between the measured level and a user defined target level. Power at the measurement point keeps stabilized against frequency response, compression artefacts and temporal or long-term drifts of amplifier and cabling. Power control is configured by means of tab “Power Control”.




- **Side Tabs**
  Only available on instruments providing multiple RF paths. The intended RF path can be selected here. Power control can be performed on multiple paths simultaneously.
- **State**
  Enables or disables the control loop on the specific RF path.
- **Sensor**
  In case of multiple connected sensors the appropriate sensor is selected here. This setting is frozen as soon as the control loop is switched on. While the control loop is active, the same sensor may not be activated in another RF path.
- **Level View**
  Displays the current measurement value of the selected sensor.
- **Target Level**
  Specifies the target level which is intended to be stabilized at the measurement point.
- **Take measurement as Target Level**
  Copies the current measurement value of the selected sensor to the Target Level. This function is only available while the control loop is switched off. The purpose of this feature is to catch the current level for further usage by the control loop.
- **Mode**
  - Auto: Power control is performed continuously.
  - Single: Power control is performed once on demand.
- **Execute Single**
  In case of mode Single, a discrete power control cycle is executed.
- **Catch Range**
  Defines the maximum deviation between the measured level and the output level which is accepted as start value for power control. If the measured level is so small that the required correction step exceeds this value, power control is paused. Intention of this setting is to prevent an unexpected level overshoot and protection against disconnected sensors.

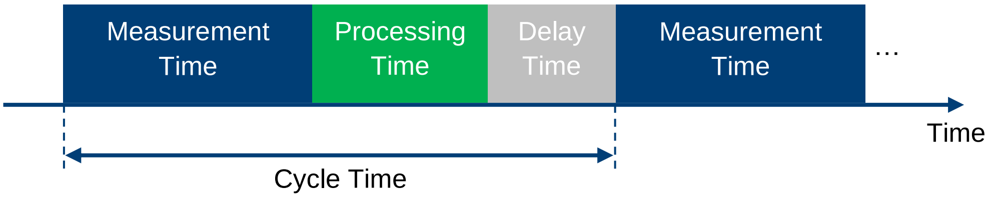
► **Delay Time**
Sets the time between two subsequent power control cycles. In case of slow drifting measurement configurations this time may be increased in order to reduce the impact of power control to generators performance, e.g. regarding setting times. Note that this value does not determine the measurement time of the sensor which is configured in the sensor configuration dialog.

► **RF Amplitude Limit**
Limits the output level of the generator to protect the DUT. The control loop does not attempt to increase the output level above this value. This setting is identical with the value of “Limit” in the level settings. It is persistent against RST, SAV/RCL and a power cycle.

► **RF setting characteristics**
This setting mirrors the value “Setting Characteristics” out of the level settings dialog. It provides settings to deal with situations in which the control loop tends to flutter. This for example happens if level setting isn’t strictly monotone at or near the target level. Especially on instruments with mechanical attenuator this effect may cause acoustic noise and abnormal wear. Select “Strictly Monotone” or “Uninterrupted” to avoid this situation. In addition, consider fixing the attenuator in level settings dialog in case of flutter.

### 6.2.1 Power Control Cycle Time

The cycle time of the power control loop is given by the measurement time of the sensor, the internal processing time and the delay time (if set):




The measurement time depends on the sensor configuration. When using an auto filter, the power of the signal and the sensor sensitivity have the main influence. With a processing time of around 1 ms, **the typical cycle time is below 10 ms** (e.g. when using a NRP8S sensor at a power of -30 dBm).

### 6.2.2 General Power Control Hints

The basic principle of NRP Power Control is to match the numeric level value delivered by the selected sensor to the value of Target Level. This is performed by adjusting the generators output power accordingly.

The measured value delivered by the sensor is not necessarily the physical level at the sensor. It might be modified by an active S-parameter set and by an offset value in the sensor settings. This typically is the approach if the sensor is plugged to a coupler or splitter. It is recommended to adjust offset or S-parameters in a way that the power values reflect the power of interest. To support this approach, the setting range of the parameter “Target Value” exceeds the margins of generator and power sensor.

In general, it is a good idea to configure the measurement setup while power control is still switched off. Adjust the power manually while observing the measured value. Check whether levels are in the expected range and stable. Otherwise take a look to the measuring setup, e.g. generator settings, cabling and sensor configuration. Be aware of the level range the sensor is specified for and avoid overload.

To get a smooth power control, avoid too small levels at the sensor. This leads to noise and long control cycles. It is recommended to stay about 30dB above the lower limit of the sensor.

If the level at the DUT is as expected, you may set it as the new target value by means of “Take measurement as Target Value”. Then enable power control to stabilize the setup.

Alternatively, the target power can be entered manually (before or after enabling power control). In this case the control loop follows the target power and for instance compensates compression artefacts in the setup.

Be aware that several modulations effect the measured level, for example pulse modulation, IQ modulation and even amplitude modulation. In case of challenging modulations make use of an appropriate sensor (e.g.

peak or pulse power sensors) and configure the sensor accordingly, especially regarding aperture time and averaging. Since NRP Power Control cannot gauge the rational of the measuring setup, there are no restrictions regarding signal and control loop configuration.

### 6.2.3 DUT Protection

Every power control loop involves the risk of power overshoot in case of misconfiguration. This typically is the case if the feedback path is interrupted, for example by wrong cable connections, wrong control direction, inappropriate level detection and so on.

Using NRP Power Control, most of these risks do not occur or can be avoided easily. Since software is in the loop, every power control step is checked for plausibility before it is performed. Power is only adjusted if the sensor is connected at all and delivers feasible results. By means of the value “Catch Range” level control is stalled if the measured value is too far away from the current generators output power. Furthermore, by setting an amplitude limit, the output power of the generator can be restricted to a safe value. This setting is persistent against power cycle and not modified by Preset and SAV/RCL.

Nevertheless, care should be taken in case of external RF amplifiers which might elevate the RF power far beyond the limit setting.

Altogether, under the following conditions the control loop is paused:

The communication with the sensor is disturbed

The measurement results are not plausible

The measurement results exceed the catch range

The amplitude limit is about to be exceeded

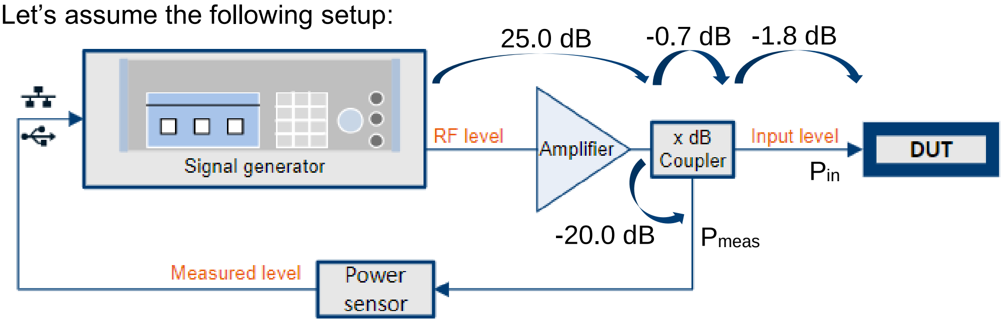
RF is switched off

An output overload condition is detected

### 6.2.4 Example

Where the basic principle of power control is easy (adjust periodically the output level of the signal generator in a way that the measured level equals the target level), there are different ways to take the measurement setup into account.

Let’s assume the following setup:




All given values for amplification/attenuation are depending on frequency. In addition, temperature and level will have an additional impact (especially from the amplifier).

**The simple way: assume an ideal coupler**

In many cases, the coupler has only a negligible effect compared to the amplifier (showing frequency response, compression and temperature effects). In this case, proceed as follows:

1. Measure the attenuation of cable connecting the coupler to the DUT
   - set the signal generator to 0 dBm and a representative RF frequency

- connect the cable directly to the signal generator and measure the level with the power sensor (here -1.8 dBm)

2. Set the RF output to Off and restore the complete measurement setup

3. Calculate the level offset $P_{in}$ – $P_{meas}$ to make the level reading of the sensor to be the level at the DUT input $P_{in}$, using the measured attenuation of the cable and the attenuations from the data sheet of the coupler. Here the level offset equals to – (-20 dB + 0.7 dB + 1.8 dB) = 17.5 dB

4. Switch to Sensor Configuration dialog, put this value to the Level Offset field and set Level Offset State to On. Please be aware, that this level offset is **not** the level offset in the level menu (affecting the level display in the head panel). In this example the second level offset is not used, so the level display shows the real output power at the RF connector.

5. Calculate the nominal gain from the RF connector to the DUT.
Here the gain equals to 25 dB – 0.7 dB – 1.8 dB = 22.5 dB

6. Switch to Power Control dialog and set the RF Amplitude Limit (maximum level at the generator connector to protect the DUT)
If the DUT can handle a maximum of 40 dBm and the gain is 22.5 dB, then set the limit to 17.5 dBm

7. Set the RF level of the generator to a value (desired DUT input level – gain).
If you want to measure at 30 dBm, set the generator level to 7.5 dBm
Activate RF output

8. If the level reading is very unstable, switch to Sensor Configuration and adjust filter and aperture value accordingly. Then switch back to Power Control dialog

9. Set the Target Level to 30 dBm

10. Switch the State on (close the control loop) and perform your measurements.
The control loop can be kept closed also when changing signal parameters. To change RF frequency, use the frequency setting in the head panel or even a frequency sweep.
To change the level, change the Target Level (but do not use level sweep).

**The advanced way: take into account the transfer functions of the coupler**

You need a four-port network analyzer to determine the S matrix of the coupler and the connected cable to the DUT.

Then proceed like shown in Using S-Parameters with R&S NRP-Z Power Sensors 1GP70 Chapter 4.3.2

► Store the S-Parameter to the sensor using the NRP-Toolkit

► Restore the complete measurement setup

► Switch to Sensor Configuration dialog and activate the S-Parameter

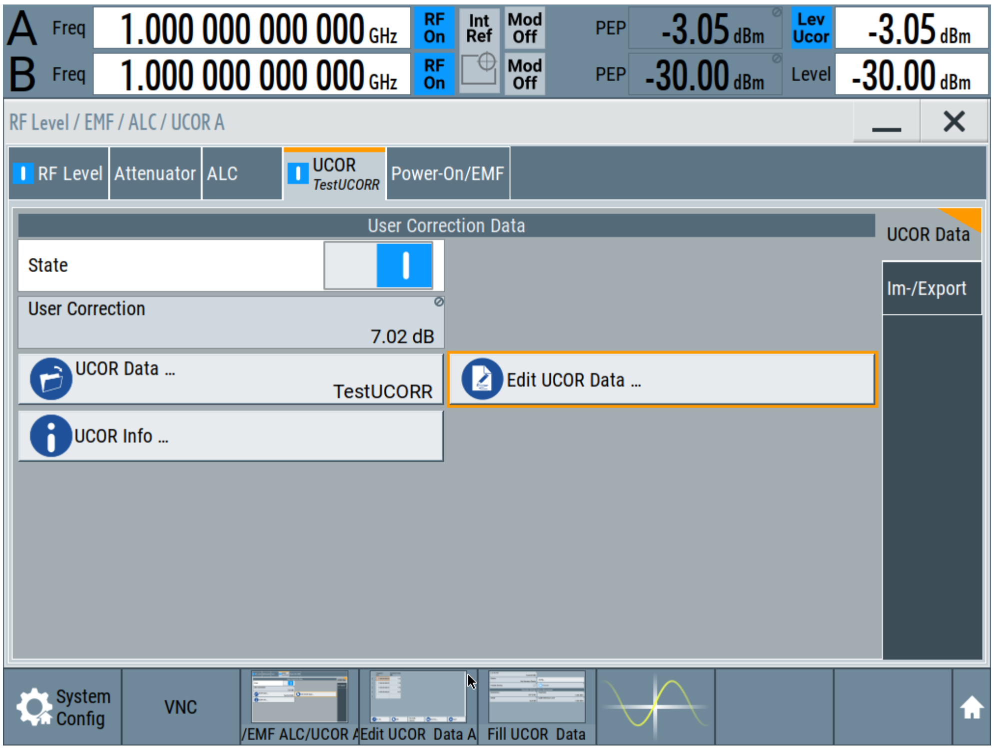
► Proceed with steps 5 to 10 from above

## 6.3 User Correction with Sensors

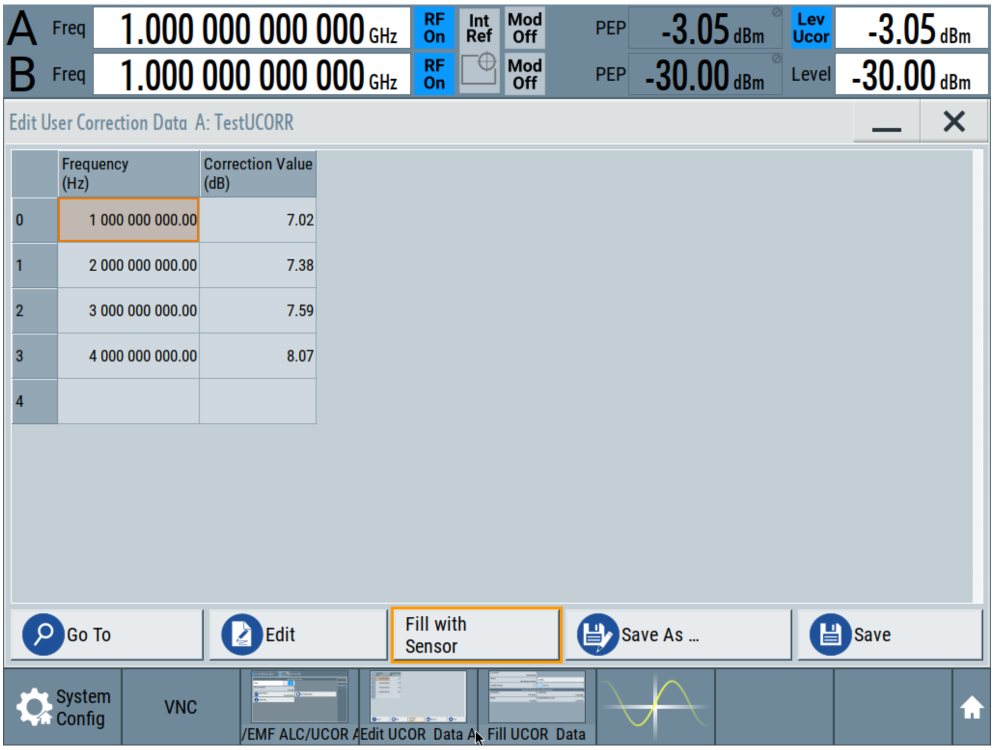
By means of the feature User Correction the frequency response of the generator can be configured according to the needs of the test setup. Typically, this is used to compensate the frequency response of external components like cables and couplers.

User Correction is available in all Rohde & Schwarz signal generators and is part of the level setting dialog, as described in the user manual.

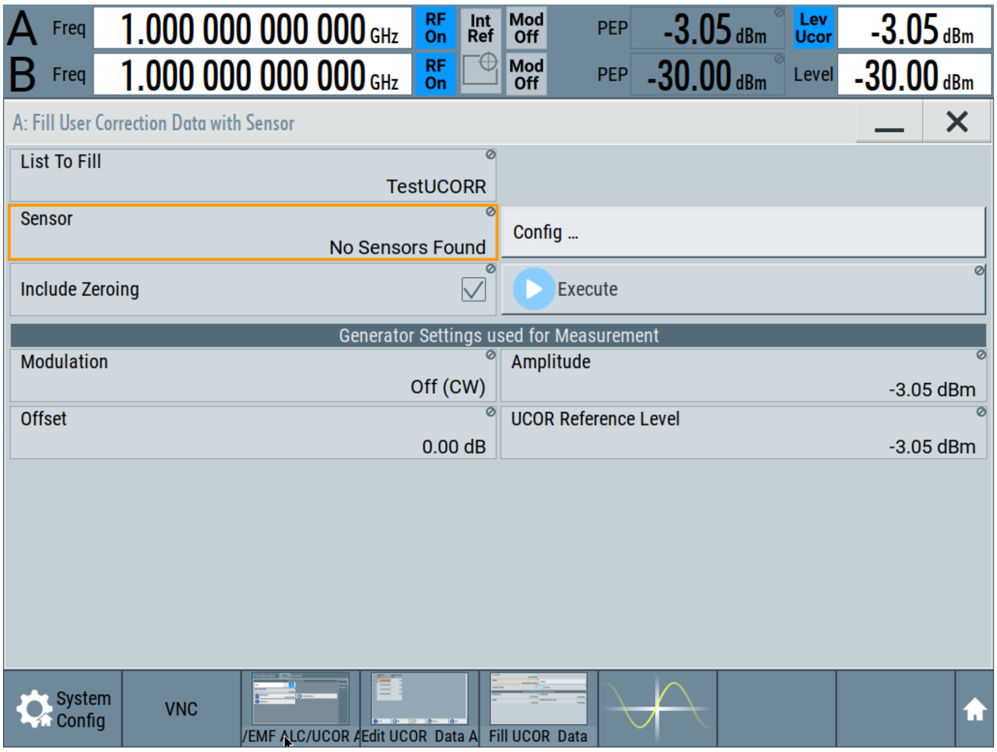
User correction is performed by means of tables containing interpolation points of frequency and corresponding level correction values. When user correction is enabled, the generator's output level is modified according to the interpolation points. User correction tables are stored as files, so an arbitrary number of them can be saved on local mass memory and they can be copied to other instruments.




The generators provide an editor to create and modify user correction tables by filling them with a list of frequency- and corresponding level correction values.




Part of this editor is a feature to fill the level correction points by means of a power sensor. Instead of evaluating and entering each single point, the correction values for a predefined list of frequencies can be determined by a power sensor in a single operation.




- **List to Fill**
  Reflects the current active user correction list
- **Sensor**
  The active sensor is selected here

- ► **Config**…
  Opens the configuration dialog for the selected sensor, as described in chapter 5.2 Sensor Configuration.
- ► **Include Zeroing**
  When checked, the measuring sequence is preceded by a zeroing operation of the sensor. The output level of the generator is suppressed automatically during zeroing.
- ► **Execute**
  Starts the evaluation of the correction points. All frequencies out of the correction list are provided by the generator step by step, the corresponding level value is measured and filled into the table.

After the level correction is completed, close the dialog and save the updated correction table in order to make use of it.

# 7 Dealing with Modulated Signals

While it is quite easy to measure constant RF signals (CW), modulated signals require special attention in order to get reproducible and stable measurement results. **This is especially required for Power Control applications, where fluctuating measurement results are reflected to the RF level setting**.

Because of the great variety of modulations and the interrelationship between signal power and data content, especially regarding digital modulation, **generators as well as sensors do not make any assumptions about the characteristics of the signal.**

When measuring modulated signals, the measurement can show fluctuation due to the modulation. If that is the case, adapt the size of the sampling window (Aperture Time) exactly to the modulation period to get an optimally stable display. If the modulation period varies or is not precisely known, you can also activate the filter function.

When filtering is activated, the selected sampling window must be 5 to 9 times larger than the modulation period so that the fluctuations caused by modulation are sufficiently reduced. The sampling values are subjected to weighting (raised-von-Hann window), which corresponds to video filtering.

If you deactivate the smoothing filter, 300 to 3000 periods are required to obtain the same effect. The sampling values are considered equivalent and are averaged in a sampling window, which yields an integrating behavior of the measuring instrument. To obtain optimum suppression of variations in the result, exactly adapt the size of the sampling window to the modulation period. Otherwise, the modulation can have a considerable influence, even if the sampling window is much larger than the modulation period.

A secure way to circumvent modulation related artefacts in power control applications is to temporary disable the modulation and execute a single power control cycle.

## 7.1 Pulse modulated Signals

These signals exist in a wide range of duty cycle, repetition frequency and pulse sequence. Depending on the individual characteristics several strategies may be appropriate:

► In case of a small and varying duty cycle consider using the peak level value instead of the averaging value. Except thermal sensors, peak values are provided by many sensors. Best result is obtained by using dedicated sensors for peak level measurement (NRP-Z8x or NRPxxP). In the sensor mapping dialog, the capability of peak level measurement of the power sensors is indicated. Be aware that peak measurements likely are noisier compared to average values.

► In case of a constant duty cycle configure an aperture time which exactly matches a single or multiple pulse periods. Alternatively, e.g. if repetition period is short against available aperture times, configure measurement times (aperture and filtering) which are long enough to deliver stable measurement results.

## 7.2 I/Q modulated Signals

The power of I/Q modulated signals may depend on data content and coding.

► In case of periodic modulation content configure an aperture time which exactly matches a single or multiple pulse periods. Alternatively, use the average power mode and configure measurement times (aperture time and filtering) which are long enough to smooth the measurement results.

► In case of repeating peak power make use of the peak power measurement feature of the sensors and configure a measurement time which reliable catches this peak power.

► In case of random power make use of average power mode and configure measurement times (aperture time and filtering) which are long enough to smooth the measurement results

► In case of power control, consider occasionally switching to CW (disabling the modulation) and execute a single power control cycle using mode “Single”.

## 7.3 Amplitude modulated Signals

Both average and peak power depend on the modulation depth and the modulation signal characteristic. In case of 100% modulation depth the peak power is about 6dB and the average power about 3dB higher compared to the unmodulated signal.

► In case of periodic modulation content like a sine wave test signal consider using average mode with appropriate aperture time or peak level measurement.

► In case of natural speak or music as modulation content make use of average mode with long enough measurement time to smooth results.

# 8 Appendix

## A Overview over Sensors and their Capabilities

This table indicates the capabilities of particular power sensors in conjunction with signal generators. The capabilities presume that they are supported by the power sensor and generator as well.

Note that all sensors require to be powered by the interface with is used for communication. When connected via USB or sensor connector the power is acquired thereover, when connected via LAN power is acquired via PoE (Power over Ethernet).

The NRQ6 sensor exclusively features a LAN interface and requires PoE+.

Sensors marked with (N) provide an optional additional LAN interface.
Sensors marked with (V) are available in a vacuum proved version.

| Sensor R&S® | Frequency range / max. Power / Connector | Technology | Peak View | Power Control | Power Analysis SMx-K28 | User Correction (UCORR) |
|---|---|---|---|---|---|---|
| **NRP6A(N)**<br>**NRP18A(N)** | 8k – 6G, 23dBm, N<br>8k –18G, 23dBm, N | EMC Average Power Sensors (Slow detector) | ✔ | ✔ | ✔ Power mode | ✔ |
| **NRP8S(N)**<br>**NRP18S(N)**<br>**NRP18S-10**<br>**NRP18S-20**<br>**NRP18S-25**<br>**NRP33S(N/V)**<br>**NRP40S(N)**<br>**NRP50S(N)**<br>**NRP67S(N/V)**<br>**NRP90S(N)**<br>**NRP90S(N)** | 10M– 8G, 23dBm, N<br>10M–18G, 23dBm, N<br>10M–18G, 33dBm, N<br>10M–18G, 42dBm, N<br>10M–18G, 45dBm, N<br>10M–33G, 23dBm, 3.50<br>50M–40G, 20dBm, 2.92<br>50M–50G, 20dBm, 2.40<br>50M–67G, 20dBm, 1.85<br>50M–90G, 20dBm, 1,35<br>50M–90G, 20dBm, 1.00 | Three-Path Diode Universal Power Sensors<br><br>**1.35 = R&S Special** | ✔ | ✔ | ✔ Power mode<br>✔ Time mode | ✔ |
| **NRP18T(N)**<br>**NRP33T(N)**<br>**NRP40T(N)**<br>**NRP50T(N)**<br>**NRP67T(N)**<br>**NRP75TWG(N)**<br>**NRP90T(N)**<br>**NRP90TWG(N)**<br>**NRP110T**<br>**NRP110TWG(N)**<br>**NRP140TWG(N)**<br>**NRP170TWG(N)** | DC–18G, 20dBm, N<br>DC–33G, 20dBm, 3.50<br>DC–40G, 20dBm, 2.92<br>DC–50G, 20dBm, 2.40<br>DC–67G, 20dBm, 1.85<br>50–75G, 20dBm, WR–15<br>DC–90G, 20dBm, 1.35<br>60–90G, 20dBm, WR–12<br>DC–110G, 20dBm, 1.00<br>75–110G, 20dBm, WR–10<br>86-144G, 20dBm, WR-8.0<br>105-175, 20dBm, WR-6.5 | Thermal Power Sensors | | ✔ | ✔ Power mode | ✔ |
| **NRP18P**<br>**NRP40P**<br>**NRP50P** | 50M-18G, 20dBm, N<br>50M-40G, 20dBm, 2.92<br>50M-50G, 20dBm, 2.40 | Peak Power Sensors (USBTMC) | ✔ | ✔ | ✔ Frequency mode<br>✔ Power mode<br>✔ Time mode<br>✔ Pulse mode | ✔ |
| **NRP-Z11**<br>**NRP-Z21**<br>**NRP-Z22**<br>**NRP-Z23**<br>**NRP-Z24**<br>**NRP-Z31**<br>**NRP-Z41**<br>**NRP-Z61** | 10M– 8G, 23dBm, N<br>10M–18G, 23dBm, N<br>10M–18G, 33dBm, N<br>10M–18G, 42dBm, N<br>10M–18G, 45dBm, N<br>10M–33G, 23dBm, 3.50<br>50M–40G, 20dBm, 2.92<br>50M–50G, 20dBm, 2.40 | Three-Path Diode Universal Power Sensors | ✔ | ✔ | ✔ Frequency mode<br>✔ Power mode<br>✔ Time mode | ✔ |
| **NRP-Z211**<br>**NRP-Z221** | 10M- 8G, 20dBm, N<br>10M-18G, 20dBm, N | Two-Path Diode Power Sensors | ✔ | ✔ | ✔ Frequency mode<br>✔ Power mode<br>✔ Time mode | ✔ |

| Sensor R&S® | Frequency range / max. Power / Connector | Technology | Peak View | Power Control | Power Analysis SMx-K28 | User Correction (UCORR) |
|---|---|---|---|---|---|---|
| **NRP-Z91**<br>**NRP-Z92** | 9k-6G, 23dBm, N<br>9k-6G, 33dBm, N | Average Power Sensors (Slow detector) | | ✔ | ✔ Frequency mode<br>✔ Power mode | ✔ |
| **NRP-Z28**<br>**NRP-Z98** | 10M-18G, 20dBm, N<br>9k - 6G, 20dBm, N | Level Control Sensors | | ✔ | ✔ Power mode | ✔ |
| **NRP-Z51**<br>**NRP-Z52**<br>**NRP-Z55**<br>**NRP-Z56**<br>**NRP-Z57**<br>**NRP-Z58** | DC-18G, 20dBm, N<br>DC-33G, 20dBm, 3.50<br>DC-44G, 20dBm, 2.92<br>DC-50G, 20dBm, 2.40<br>DC-67G, 20dBm, 1.85<br>DC-110G, 20dBm, 1.00 | Thermal Power Sensors | | ✔ | ✔ Frequency mode<br>✔ Power mode | ✔ |
| **NRP-Z81**<br>**NRP-Z85**<br>**NRP-Z86** | 50M-18G, 20dBm, N<br>50M-40G, 20dBm, 2.92<br>50M-44G, 20dBm, 2.40 | Wideband Power Sensors | ✔ | ✔ | ✔ Frequency mode<br>✔ Power mode<br>✔ Time mode<br>✔ Pulse mode | ✔ |
| **NRQ6 LAN** | 50M−6G, 20dBm, N | Frequency selective sensor | ✔ | ✔ | Not available | ✔ |

# B Overview over Generators and their Capabilities

This table shows which features are available on specific Rohde & Schwarz signal generators.

To take advantage of the indicated capabilities ensure that the generator as well as the sensor are equipped with the latest firmware. The specific features require to be supported by the generator and the sensor as well.

### Current Signal Generators

| Generator | Support of LAN sensors | Power Viewer | Power Control / required Firmware | Power Analysis | UCORR Fill with sensor |
|---|---|---|---|---|---|
| **SMW200A** | Yes | Yes | Yes, >= 5.20 | No | Yes |
| **SMM100A** | Yes | Yes | Yes, >= 5.20 | No | Yes |
| **SMA100B** | Yes | Yes | Yes, >= 5.20 | SMAB-K28 | Yes |
| **SMB100B** | Yes | Yes | Yes, >= 5.20 | No | Yes |
| **SMBV100B** | Yes | Yes | Yes, >= 5.20 | No | Yes |
| **SMCV100B** | Yes | Yes | Yes, >= 5.20 | No | Yes |

### Legacy Signal Generators

| Generator | Support of LAN sensors | Power Viewer | Power Control | Power Analysis | UCORR Fill with sensor |
|---|---|---|---|---|---|
| **SMU200A** | No | Yes | No | No | Yes |
| **SMA100A** | No | Yes | Yes | SMA-K28 | Yes |
| **SMB100A** | Yes | Yes | Yes | No | Yes |
| **SMC100A** | No | Yes | Yes | No | Yes |
| **SMF100A** | No | Yes | Yes | SMF-K28 | Yes |
| **SMBV100A** | No | Yes | No | No | Yes |

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The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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PAD-T-M: 3572.7186.00/02.00/EN


1GP141 | Version 2 | 10.2023
Application Note | Using R&S Power sensors with R&S signal generators
Data without tolerance limits is not binding | Subject to change