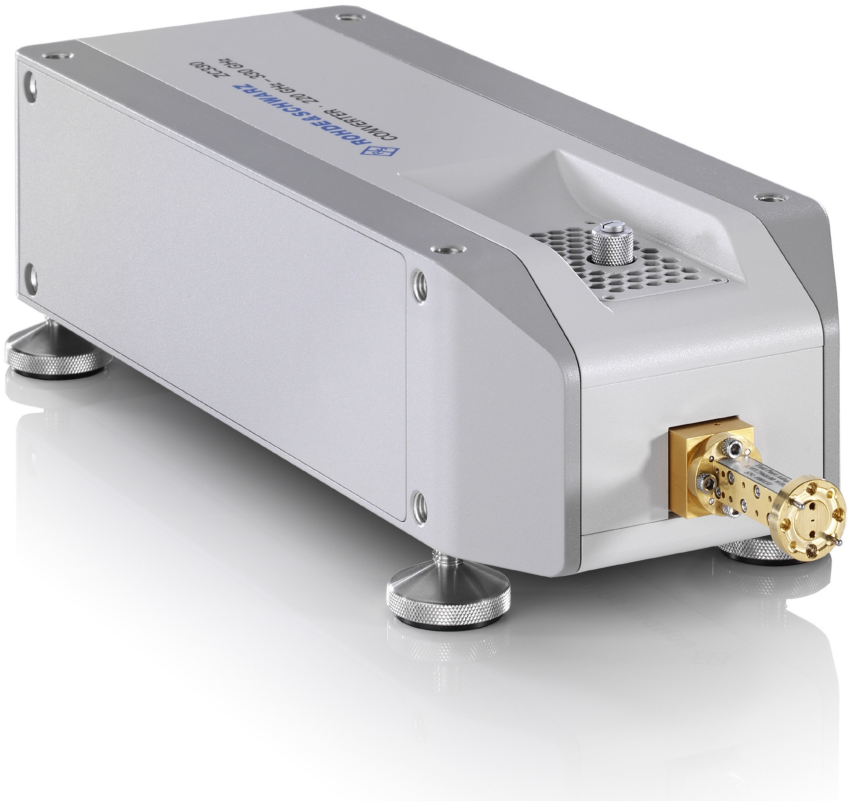
R&S®Converter Leveling Tool
Software Utility
Getting Started



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Version 04

ROHDE&SCHWARZ
Make ideas real

Mühldorfstr. 15, 81671 München, Germany
Phone: +49 89 41 29 - 0
Email: info@rohde-schwarz.com
Internet: www.rohde-schwarz.com

1331.3069.02 | Version 04 | R&S®Converter Leveling Tool

Throughout this manual, R&S® is abbreviated as R&S. The "R&S®Converter Leveling Tool" is abbreviated as "Leveling Tool".

Contents

1 Introduction

This manual describes the installation, configuration and use of the R&S®Converter Leveling Tool (Leveling Tool for short), a free software utility for vector network analyzers R&S ZNA, R&S ZVA (including R&S ZVA110), andR&S ZVT, operated in combination with frequency converters R&S ZCxxx and/or R&S ZVA-Zxxx(E).

The Leveling Tool simplifies and improves the determination of correction data the vector network analyzer can use to control the RF output power at the frequency converter test ports. Only if these correction data are available for the related frequency converter ports, the following measurements can be extended to setups involving frequency converters within their supported frequency and power ranges:

1. frequency sweeps with correct and constant test port power (= channel base power)
2. power sweeps with correct test port power steps

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- For a complete list of required equipment and possible combinations, refer to Chapter 3, "Required Equipment", on page 8.
- For an introduction to the tool and its operation, refer to Chapter 9, "Working with the Leveling Tool", on page 23.
- For detailed information about frequency converters and their use, refer to the application notes and manuals quoted in Chapter 10, "Additional Information", on page 33.

2 Leveling Procedure

The purpose of frequency converter leveling is to determine the nominal RF input power $P_{RF\text{-}In}$ at the converter input that is required to generate a particular RF converter output power $P_{RF\text{-}Out}$ at (output) frequency f.

To achieve this, the RF output power is measured on a "leveling grid", i.e. at equidistant RF input power levels $P_{RF\text{-}In,\ i}$ and frequencies f_j. Two-dimensional interpolation is then used to obtain the appropriate input level for the desired output level at a given frequency. Selecting smaller step sizes can improve the interpolation accuracy, at the cost of an increased leveling duration.

For each frequency converter port, the leveling procedure consists of the following steps:

1. **Reference receiver calibration**
   During this step, connect a power meter to the test port of the respective frequency converter. The calibration consists of a single frequency sweep f_1, ..., f_n during which $P_{RF\text{-}Out}(f_j)$ and $P_{REF}(f_j)$ are recorded, where $P_{REF}(f_j)$ denotes the power measured by the VNA reference receiver.
   The sweep is performed at the frequency converter's maximum RF level, which is typically advantageous w.r.t. measurement time and accuracy at the power meter.
   For the subsequent steps, the correction factors $c(f_j) = P_{RF\text{-}Out}(f_j) - P_{REF}(f_j)$ (on logarithmic scale) are assumed to be independent of the input power level $P_{RF\text{-}In}$.

2. **RF input power calibration**
   This is the actual leveling step, i.e. for each point on the leveling grid, the RF output power $P_{RF\text{-}Out}(P_{RF\text{-}In,\ i},f_j)$ is determined.
   However, during this step it is sufficient to measure the reference receiver power $P_{REF}(P_{RF\text{-}In,\ i},f_j)$, which can be performed much faster and with a much higher dynamic range compared to measuring the RF output power using a power meter. With the correction factors $c(f_j)$ obtained in step 1, the RF output power can then be calculated as $P_{RF\text{-}Out}(P_{RF\text{-}In,\ i},f_j) = c(f_j) + P_{REF}(P_{RF\text{-}In,\ i},f_j)$ (on logarithmic scale). The power meter is no longer required.

3. **Waveguide attenuator calibration** (E-type frequency converters only)
   This is a mandatory step for frequency converters with electronic attenuators (E-type converter) that are controlled by a R&S ZVA or R&S ZVT via option R&S ZVA-B8 (see Chapter 3, "Required Equipment", on page 8).
   The Leveling Tool records the characteristic of the converter's electronic waveguide attenuator. The procedure is similar to that of step 2. The power meter is not required!

- Controlling the electronic attenuator of an E-type converter is not supported by the R&S ZNA, and hence the waveguide attenuator calibration is not available. However, E-type converters can also be used with their default (unattenuated) output power.
- To improve the accuracy of $P_{RF\text{-}In}$, it is recommended to perform complementary power flatness calibrations at the related analyzer ports (including the cables connecting the analyzer port to the RF Input of the frequency converter) before starting the frequency converter leveling.

3 Required Equipment

The Leveling Tool is suitable for test systems consisting of a vector network analyzer R&S ZNA, R&S ZVA (including R&S ZVA110), orR&S ZVT, in combination with one or more frequency converters R&S ZCxxx or R&S ZVA-Zxxx(E); see Chapter 3.3, "Frequency Converters ", on page 9

3.1 Vector Network Analyzers R&S ZNA

Up to n converters can be operated with an n-port instrument. However, with n converter ports, the LO signal for the converters must be provided either by the optional LO Out of the R&S ZNA (R&S ZNA-B8) or by an external signal generator (see reference [1] in Chapter 10, "Additional Information", on page 33 for details).

Supported firmware versions

The present version of the Leveling Tool requires a R&S ZNA with firmware version 1.90 or higher.

Free firmware updates are available for download on the R&S ZNA product pages (http://www.rohde-schwarz.com/product/zna). Refer to the instrument's help system or user manual for installation instructions.

Required Options

- For two-port instruments, which can only have one internal source, the LO signal for the converters must be provided via R&S ZNA-B8 or an external generator. If R&S ZNA-B8 is used, then option R&S ZNA-B26 is also required.
- Option R&S ZNA-B26 "Direct IF Access" or R&S ZNAxx-B16, "Direct Generator/ Receiver Access" to connect the Meas and Ref ports of the converters.
- Option R&S ZNA-K8, "Converter Control".

3.2 Vector Network Analyzers R&S ZVA and R&S ZVT

To drive one or more frequency converters, the R&S ZVA or R&S ZVT VNA must have a maximum frequency ≥ 20 GHz.

The four-port instruments R&S ZVA24/40/50/67 or an R&S ZVT20 with a minimum of four ports provide the full functionality. It is also possible to operate the frequency converters with R&S ZVA24, R&S ZVA40, or R&S ZVA50 two-port instruments, but this requires an additional external signal generator (see reference [1] in Chapter 10, "Additional Information", on page 33 for details).

For R&S ZVA67 and other analyzers equipped with the latest synthesizer board Sy4G, each test port is driven by its own, independent source. R&S ZVA67 two-port instruments may be operated either with a single frequency converter or with two frequency

converters, if an external signal generator is used. On four-port instruments R&S ZVA67, an external signal generator is necessary to realize setups with 4 converter ports.

The R&S ZVT20 can be operated with up to four frequency converters (depending on the number of installed ports). With an additional external signal generator, up to 6 frequency converters are supported for frequency leveling.

The R&S ZVA110 enables millimeter-wave measurements from 10 MHz to 110 GHz in a continuous sweep. Converter ports of other R&S ZVA or R&S ZVT-based test systems only cover the frequency range of the converter, e.g. 75 GHz to 110 GHz for R&S ZVA-Z110(E).

Required Options

- Option R&S ZVA<n>-B16, "Direct Generator/Receiver Access" at each analyzer port
- Option R&S ZVA-K8, "Converter Control"
- Option R&S ZVA-B8 (to establish the power control connection between the analyzer and the frequency converters with electronic attenuators)

Supported firmware versions

The present version of the Leveling Tool requires a R&S ZVA or R&S ZVT firmware version V3.60 or higher. For the R&S ZVA110 a firmware version 4.11 or higher is required.

Free firmware updates are available for download on the R&S ZVA and R&S ZVT product pages (http://www.rohde-schwarz.com/product/zva/http://www.rohde-schwarz.com/product/zvt). Refer to the instrument's help system or operating manual for installation instructions.

3.3 Frequency Converters

A test system comprises one or more frequency converters R&S ZCxxx or R&S ZVA-Zxxx(E) plus all the necessary cabling to connect the frequency converters to the analyzer.

Best leveling results are obtained for frequency converters R&S ZCxxx, R&S ZVA-Z110 Var.03, and R&S ZVA-Z90. For R&S ZVA and R&S ZVT with option R&S ZVA-B8, also frequency converters with electronic attenuators (R&S ZVA-Z110E and R&S ZVA-Z90E) provide precise leveling results.

Other frequency converters have limited ability to control the RF output power via the RF input power and therefore generally do not allow for effective power correction over wide frequency and power ranges. However the Leveling Tool also performs the calibration steps with these frequency converters.

3.4 Power Meter

The frequency range and waveguide interface of the power meter must be in accordance with the used frequency converter.

Recommended Power Meters

- R&S NRP110T or its predecessor R&S NRP-Z58 for frequencies up to 110 GHz

Figure 3-1: R&S NRP110T

This power meter is equipped with a 1mm coax connector, so a suitable WRxx to 1 mm adapter is required. For details concerning its usage, see the R&S NRPxxT(N) or R&S NRP-Z Power Sensors User Manual and references no [3], [4], and [5] in Chapter 10, "Additional Information", on page 33.

- VDI Erickson power meters PM5 or PM4 for frequencies above 110 GHz

The power meter's sensor head is equipped with a WR10 waveguide connector, so depending on the frequency converter model a suitable WRxx to WR10 waveguide taper is required. For details concerning its usage, see the respective PMx manual that is available from the VDI Erickson power meter product pages (http://vadiodes.com/index.php/en/products/power-meters-erickson).

- Adjust the range switch of the PMx so that the maximum RF output power of the frequency converter is within the selected power range. See the data sheet of the related converter type and the suitable PMx manual for details.
- To increase calibration accuracy, zeroing the PMx power meter is recommended before calibration step 1 (reference receiver calibration). Zeroing is particularly important if low measurement ranges are required. After mounting the sensor head to the frequency converter, allow sufficient thermal settling time (1 hour is recommended). After the system has reached thermal equilibrium, switch off the converter's RF output power by selecting Channel – [Pwr Bw Avg] > "Power" > "RF Off All Chanels" on the VNA. Press the [ZERO] button on the front panel of the PMx. After that, reactivate the converter's output power by deselecting "RF Off All Chanels".

Other power meters supported by the VNA

In general, the Leveling Tool can work together with any power meter that is supported by the analyzer firmware. Setup, configuration and operation are similar for all power meters, however some advanced communication features are limited to R&S NRP power sensors. For information see "Meas. Delay Time" on page 25.

4 Installation

The Leveling Tool can be installed on a PC or instrument running Windows XP SP3 or higher. To install it, download the suitable installer (32-bit or 64-bit) from the R&S ZNA software page (https://www.rohde-schwarz.com/software/zna/), run it, and follow the on-screen instructions.

On a R&S ZNA or a PC with Windows 10, the Leveling Tool can be installed and run without issues.

Operation with power meters VDI Erickson PMx

VDI Erickson PMx power meters must be connected **to the Leveling Tool PC** (see Chapter 5.2, "Setup with a VDI Erickson Power Meter", on page 13).

- Due to driver issues with these power meters, the Leveling Tool PC must run Windows 10. In particular, the Leveling Tool must be run from a separate PC, if a R&S ZVA or R&S ZVT with Windows XP or Windows 7 is used.
- The control connection between VNA and power meter (via the Leveling Tool PC) requires VISA on the VNA.

VISA

In the context of the Leveling Tool, VISA is required on the Leveling Tool PC, to establish a control connection between Leveling Tool and VNA firmware. Furthermore, it is required on the instrument, if the control connection between the VNA firmware and the power meter is established using VISA, e.g. for VDI Erickson PMx; see the documentation of your VNA for more information.

RS-VISA is bundled with the Leveling Tool installer and is also part of the R&S ZNA firmware. There are only a few scenarios that require a dedicated VISA installation on the instrument.

- R&S ZVA or R&S ZVT running Windows XP
  If you want to run the Leveling Tool on the instrument, or if the power meter control connection requires VISA (e.g. for VDI Erickson PMx), then you have to install a suitable NI VISA runtime on the instrument.
  (The installation of the RS-VISA bundled with the Leveling Tool fails on instruments running Windows XP!)
- R&S ZVA or R&S ZVT running Win7 or Win10
  If the power meter control connection requires VISA, but VISA is not installed on the instrument (e.g. if the Leveling Tool is not installed on the instrument), then you have to install RS-VISA or a suitable NI VISA runtime on the instrument.
- All instruments
  If the power meter is connected via an USB-to-IEC/IEEE Adapter R&S ZVAB-B44, then NI VISA must be installed on the instrument. This requirement is not specific to the Leveling Tool; see the documentation of your VNA for more information.

5 Remote Control Connections

In the following, we assume that the leveling tool is installed on a separate PC (the "Leveling Tool PC").

This chapter describes the required remote control connections between Leveling Tool PC, VNA, and power meter. The required connections are the same for all supported instruments, so we use the R&S ZNA as a typical example.

5.1 Setup with R&S NRP110T or R&S NRP-Z58

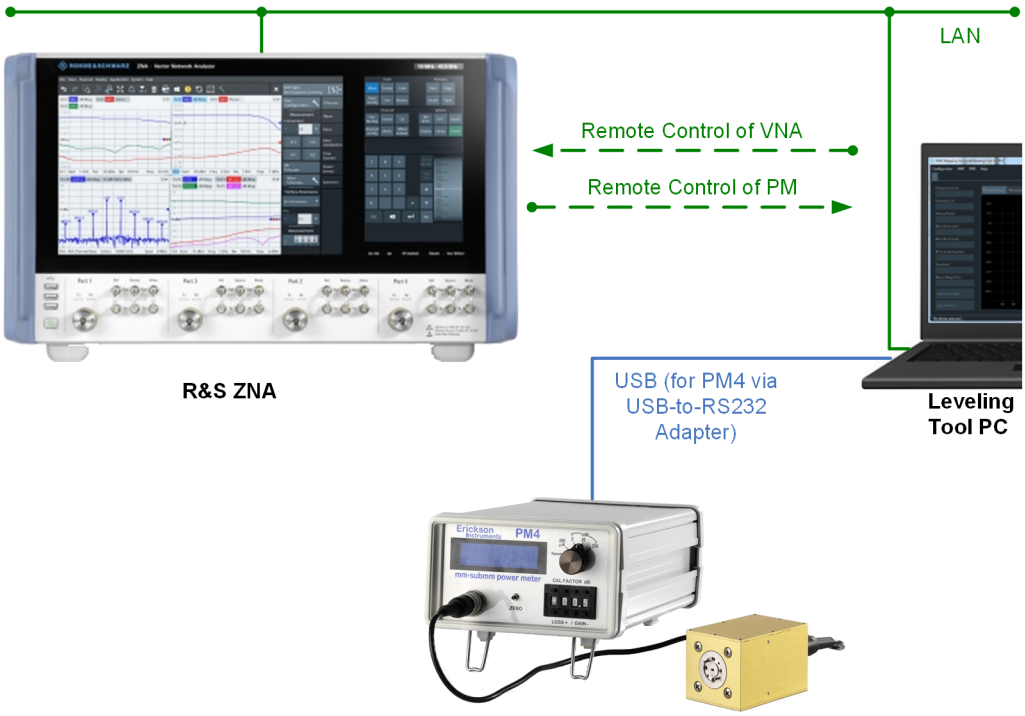
These power meters are supported by the analyzer firmware. They can be connected to any of the USB connectors on the front or rear panel of the analyzer.

The Leveling Tool uses a LAN (or GPIB) connection to operate the analyzer (read/write settings, query results).

5.2 Setup with a VDI Erickson Power Meter

The VDI Erickson power meters PM5 and PM4 are not natively supported by the analyzer firmware. The PMx control unit is connected **to the Leveling Tool PC** via USB. The PM5 is equipped with a USB interface, for the PM4 an additional USB-to-RS232 adapter is required unless the Leveling Tool PC is equipped with an RS232 interface.

The driver for the PM5 or the USB-to-RS232 adapter has to be installed on the Leveling Tool PC before running the tool.



The Leveling Tool uses a LAN connection operate the VNA (read/write settings, query results). To add support for the VDI Erickson power meters, the Leveling Tool installs a suitable power meter driver on the VNA and sets up an external power meter connection using this driver. The Leveling Tool acts as an adapter between the higher-level power meter interface specified by the driver file, and the low-level serial interface of the VDI Erickson power meters.

Remote control of a PMx requires:

- a LAN connection between the VNA and the Leveling Tool PC (USB and GPIB are only supported for VNA remote control)
- VISA on the VNA (see "VISA" on page 12)

6 Preparing Analyzer and Converters

Before using the Leveling Tool, establish all connections between the frequency converters and the network analyzer. For details, refer to references no. [3] and [4] in Chapter 10, "Additional Information", on page 33.

6.1 Vector Network Analyzers R&S ZNA

At the analyzer GUI, proceed as follows:

► Open the "Converter Configuration" dialog (System – [Setup] > "Frequency Converter" > "Frequency Converter...") and configure the connected converters and signal paths as described in the online help of the analyzer firmware; see [2] in Chapter 10, "Additional Information", on page 33.

Figure 6-1: R&S ZNA Converter Configuration dialog

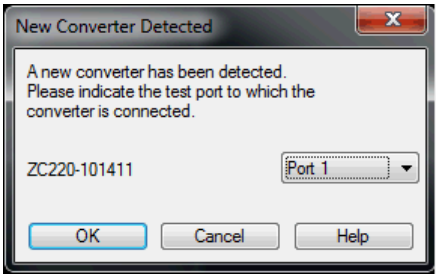
For frequency converters of the R&S ZCxxx family, make sure that each converter (identified by its serial number) is assigned to the correct analyzer port.

6.2 Vector Network Analyzers R&S ZVA and R&S ZVT

If R&S ZVA-B8 is installed and you are using converters with electronical attenuators, don't forget to establish the the power control cable connection.

At the analyzer GUI, proceed as follows:

1. Establish all connections (including the power control cable connection, if applicable) between the frequency converters and the network analyzer. For details refer to reference no. [3] or [4].
2. If you use a frequency converter of the R&S ZCxxx family that has never been connected to the respective VNA before, connect it to the VNA via USB and follow the on-screen instructions of the "New Converter Detected" dialog.



3. Ensure that the frequency converter mode of the VNA is active. Open the "System > System Configuration > Frequency Converter" tab and select the "Type" and "Use of External Sources" according to your frequency converter type and test setup. For details refer to reference no. [2] in Chapter 10, "Additional Information", on page 33.

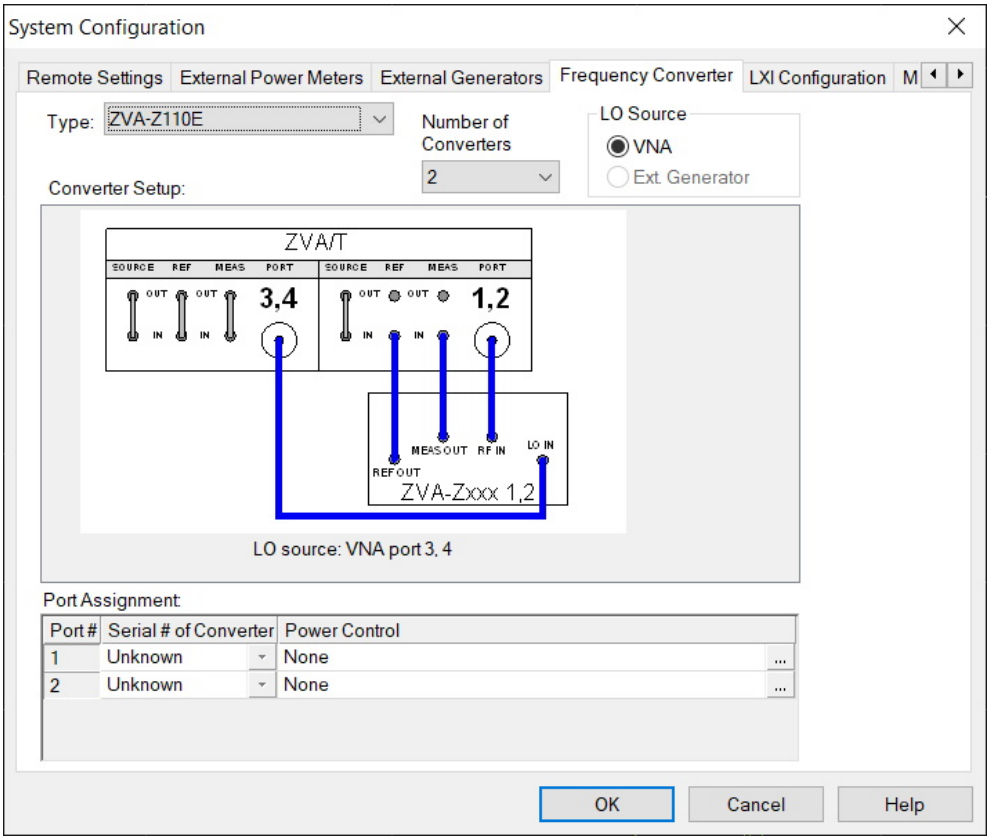
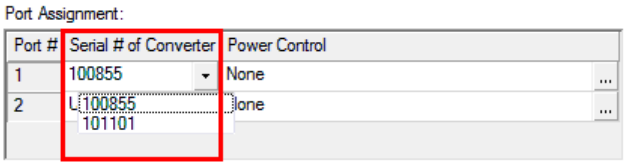


Figure 6-2: System Configuration > Frequency Converter tab

For frequency converters of the R&S ZCxxx family make sure the converters are individually assigned to their respective ports:



7 Program Start and VNA Remote Control

Before starting the Leveling Tool, ensure that you have carried out all the preparative steps described in Chapter 6, "Preparing Analyzer and Converters", on page 15.

Whenever you start the Leveling Tool, you are requested to establish a remote control connection to the analyzer.

1. On the Leveling Tool PC, select "Leveling Tool" from the Windows Start menu.

   You are prompted with the "Select Connection Configuration" dialog:

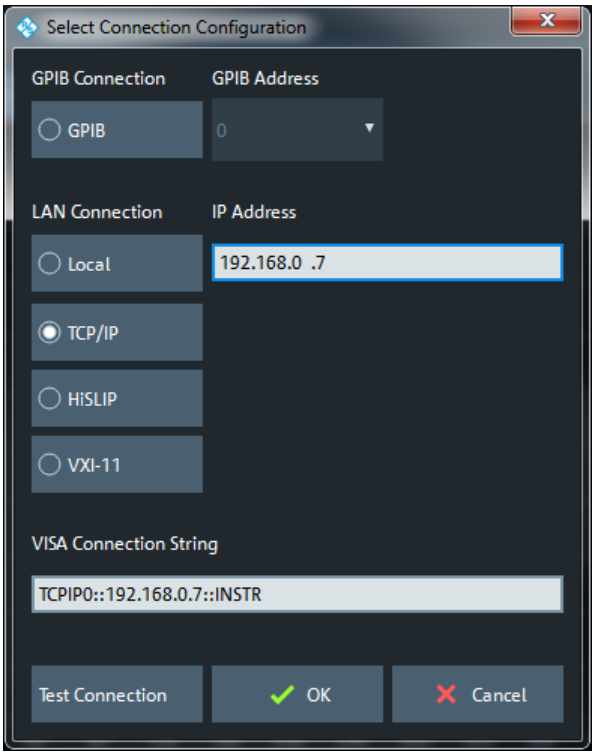


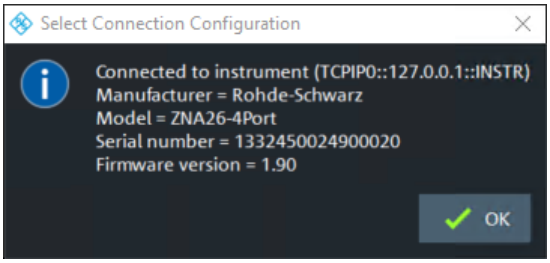
Figure 7-1: VNA connection configuration

2. In the "Select Connection Configuration" dialog, select/specify the appropriate connection properties for your analyzer.
   E.g., select connection type "TCP/IP", "HiSLIP" (R&S ZNA only), or "VXI-11" and enter the "IP Address" of the VNA. If the Leveling Tool is installed directly on the VNA, select "Local" and enter "IP Address" 127.0.0.1 (default).

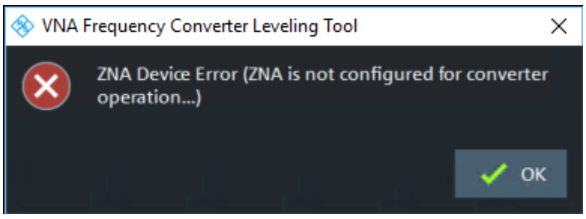
   The "VISA Connection String" is automatically composed from the GPIB/LAN settings, but can also be entered manually.

3. Select "Test Connection" to test the communication between Leveling Tool and analyzer.

   If the connection was successfully established and the VNA is prepared for frequency converter operation, the connection test is successful:



Otherwise a warning message is displayed, e.g.



Select "OK" to return to the "Select Connection Configuration" dialog.

4. In the "Select Connection Configuration" dialog, click "OK" to establish the connection or "Cancel" to abort the connection attempt.

   You can start another connection attempt by selecting "Configuration" from the main window of the Leveling Tool (see "Configuration" on page 24).

On subsequent program starts, the configuration of the last successful connection is reused.

8 External Power Meters: Control Connection

Before the leveling can be performed, the power meter has to be configured in the analyzer firmware and the control connection between analyzer and power meter must be established.

8.1 R&S NRP110T or R&S NRP-Z58

To establish a remote control connection between the VNA and an R&S NRP110T or R&S NRP-Z58, the power meter has to be connected to the analyzer via USB (see Chapter 5.1, "Setup with R&S NRP110T or R&S NRP-Z58", on page 13). If "Auto Config R&S NRP Power Sensors" is enabled, the power meter is automatically configured by the analyzer firmware, otherwise it has to be configured manually. See reference [2] for background information.

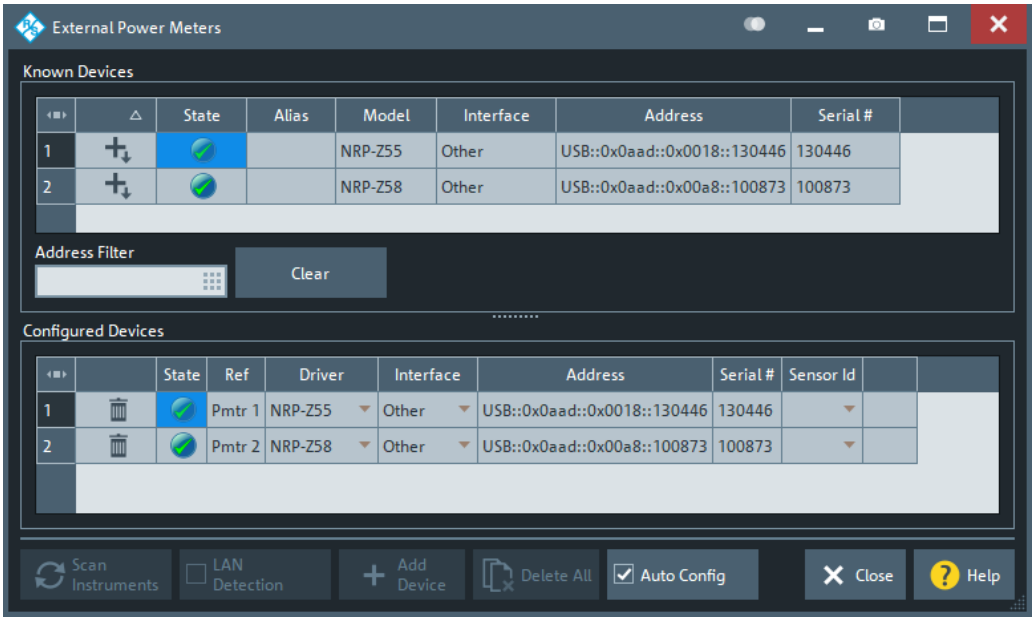


Figure 8-1: Auto config for R&S NRP-Z58 (R&S ZNA)

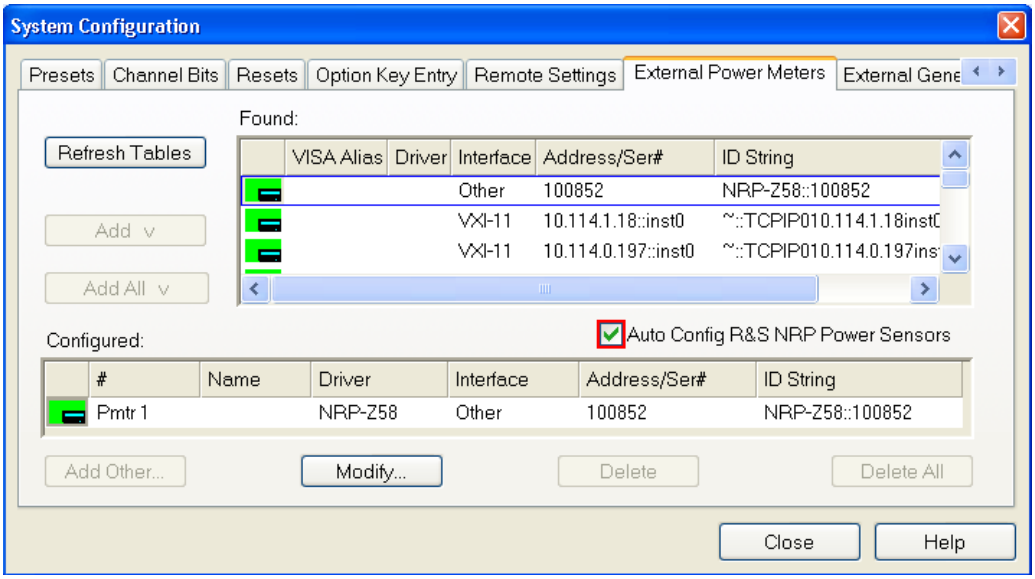


Figure 8-2: Auto config for R&S NRP-Z58 (R&S ZVA or R&S ZVT)

8.2 VDI Erickson PM4 or PM5

The control connection between the VNA and a VDI Erickson PM5 or PM4 is established via the Leveling Tool. It consists of two segments:

- an IP connection between analyzer and Leveling Tool PC (the latter providing the remote control interface to the "real" power meter)
- a serial connection between Leveling Tool PC and power meter (see Chapter 5.2, "Setup with a VDI Erickson Power Meter", on page 13)

To set up the power meter, select "PM4" or "PM5" from the main window of the Leveling Tool (see Figure 9-1). You are prompted with the following dialog:

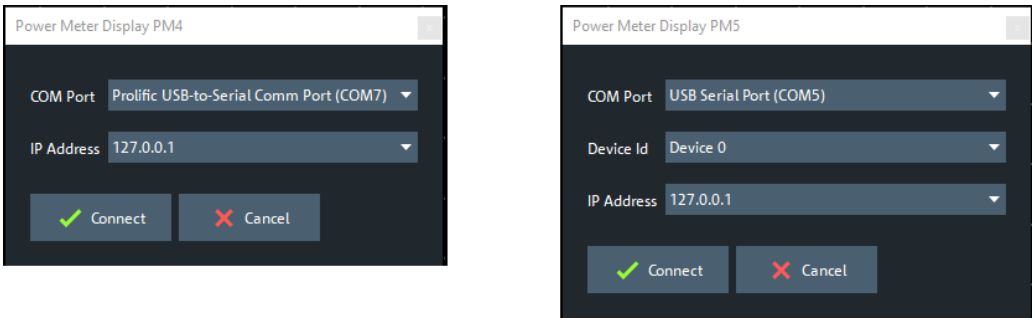


Figure 8-3: Connection configuration for PM4 (left) and PM5 (right)

With suitable COM port and LAN IP settings, the analyzer can connect to the power meter via the Leveling Tool:

- **"COM Port"**

Select the COM port the power meter is connected to, either directly or via USB to RS232 adapter

- **"Device Id"** (PM5 only)
  Only relevant if multiple PM5s are connected to the Leveling Tool PC. In this case, select the USB device ID of the PM5 that is used for leveling.
  Hint: To find out the device ID of a connected device, locate it in the Windows Device Manager and select "Properties" > "Details" > "Property: Hardware Ids").
- **"Used LAN IP for SCPI"**
  This is the IP address of the Leveling Tool PC in the network. In case the Leveling Tool PC is equipped with multiple network interfaces, select the (IP address of the) network interface that is used for communication with the VNA.
- **"Connect"**
  On "Connect", the Leveling Tool takes the following actions:
  – configure the corresponding power meter in the analyzer firmware
  – establish the required serial connection to the power meter

In the Leveling Tool, when the connection is established, the "Power Meter Display PMx" dialog indicates the power level that is measured at the related PMx.

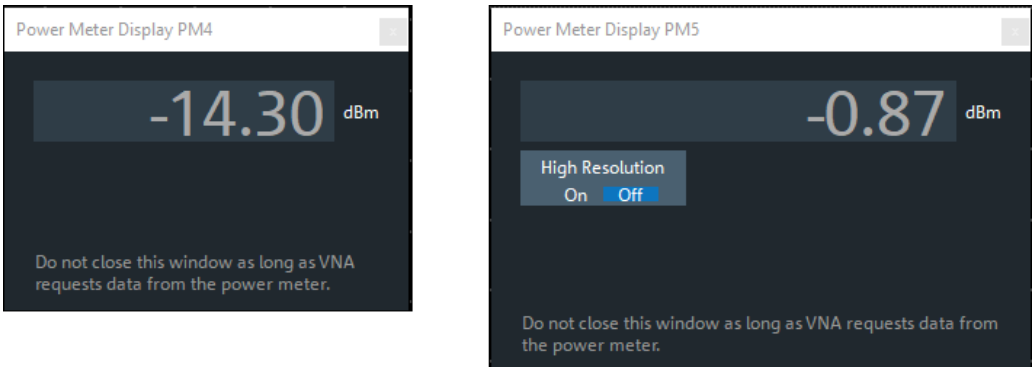


Figure 8-4: Active connection display for PM4 (left) and PM5 (right)

Keep this dialog open as long as you want to use the related PMx: closing it terminates the external power meter connection.

Make sure the remote control connection between Leveling Tool and analyzer is established before connecting to the PMx. Otherwise the analyzer firmware does not configure the power meter and leveling is not possible.

9 Working with the Leveling Tool

Run the Leveling Tool and establish the required remote control connections as described in Chapter 7, "Program Start and VNA Remote Control", on page 18 and Chapter 8, "External Power Meters: Control Connection", on page 20. The Leveling Tool now displays its main window:

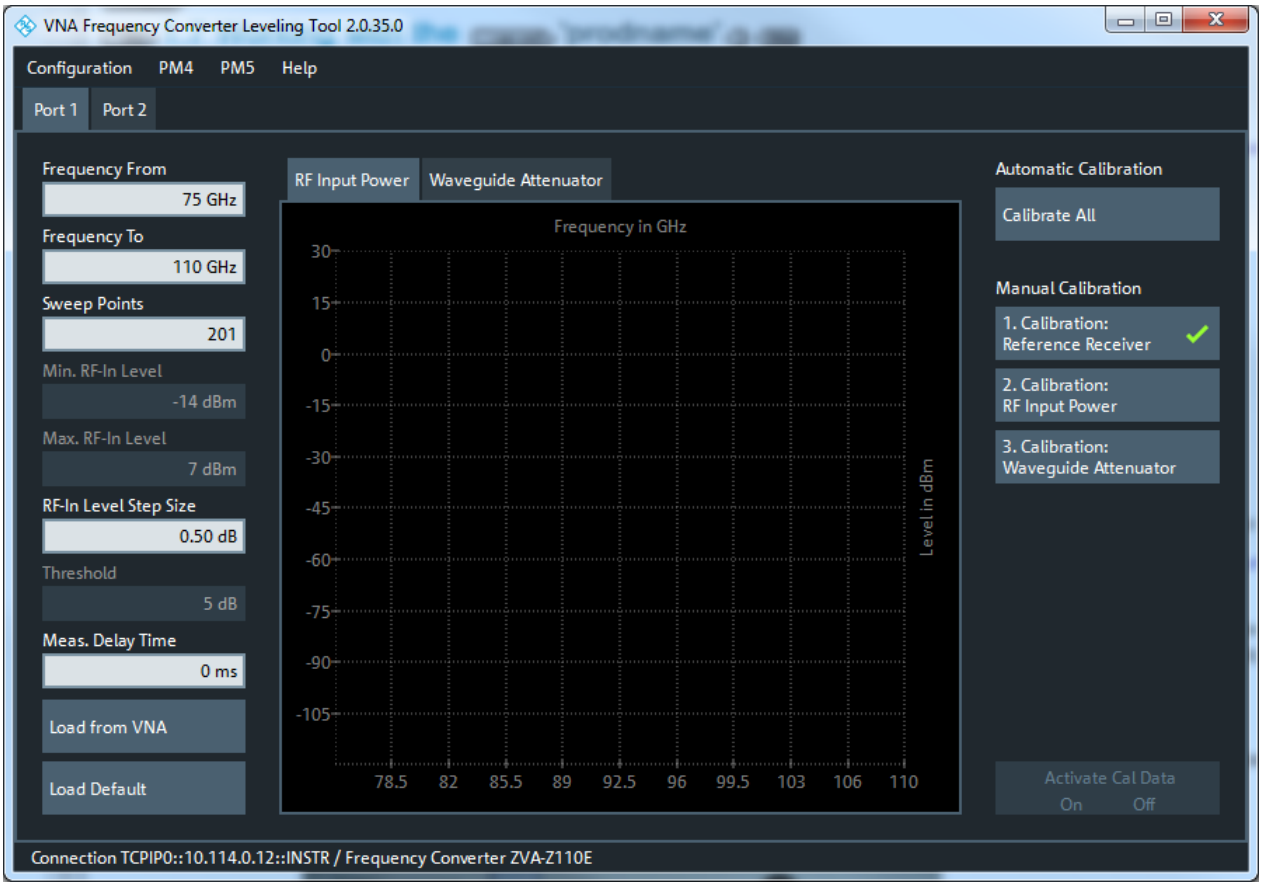
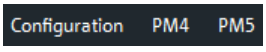


Figure 9-1: Leveling Tool: main window

The menu bar at the top of the window gives access to the remote control connection configuration. Each tab in the client area represents a frequency converter port, according to the selected "Use of Resources" (see Figure 6-1). For each port that requires exact output levels, perform the leveling tasks as described in Chapter 9.4, "Operating the Leveling Tool", on page 31.

9.1 Remote Control Connection Functions

The items in the menu bar (except "Help") allow you to set up the required remote control connections.

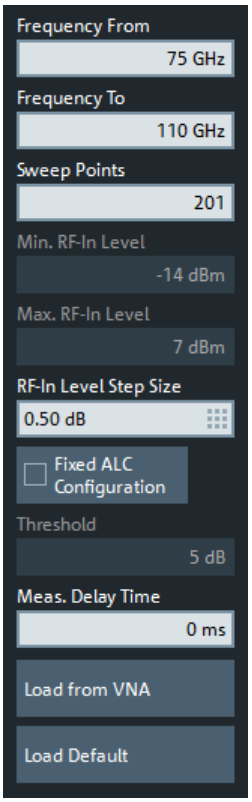


Configuration
Opens the "Select Connection Configuration" dialog that allows to establish a remote control connection to a VNA. See Chapter 7, "Program Start and VNA Remote Control", on page 18.

PM4/PM5
Opens the configuration dialog for VDI Erickson power meters PM4 and PM5, respectively. See Chapter 8.2, "VDI Erickson PM4 or PM5", on page 21.

9.2 Calibration Settings

The left part of each tab in the Leveling Tool main window allows you to define the calibration settings for the respective port. For background information, see Chapter 2, "Leveling Procedure", on page 6.



Frequency From/To and Sweep Points
Defines the frequency values of the leveling grid.

By default the Leveling Tool uses the standard frequency range of the selected frequency converter type and 201 sweep points. However you can also specify different parameters or load the current sweep settings from the analyzer (see "Load from VNA" on page 26).

The higher the number of "Sweep Points" the more accurate the leveling, but also the more time-consuming the reference receiver calibration (see the explanations for "Meas. Delay Time" on page 25). The number of sweep points is limited to 10001.

Min./Max. RF-In Level and RF-In Level Step Size
Defines the RF-In power values of the leveling grid.

"Min. RF-In Level" and "Max. RF-In Level" are read-only: the Leveling Tool automatically selects an input range optimized for the detected frequency converter type. However, you can change the "RF-In Level Step Size" from its default 0.5 dB to 0.2 dB (higher leveling accuracy, but the leveling procedure takes more time), 1 dB or 2 dB (lower leveling accuracy, but the leveling procedure takes less time). Setting a step size of 0.1 dB is also possible, but is only recommended for converters with extremely steep power transfer characteristics.

If Fixed ALC Configuration is checked, "RF-In Level Step Size" is set to 1 dB and disabled.

Fixed ALC Configuration
This checkbox is available for R&S ZNA only.

If checked, RF-In Level Step Size is fixed to 1dB and the corresponding input field is disabled.

Threshold
This read-only value is available for frequency converters with electronic only. It indicates a threshold value for the output power at the frequency converter's test port. Below the threshold, part of the power reduction is controlled by the electronic attenuators in the frequency converters. Above the threshold, the power reduction is controlled by the RF signal fed in at RF IN.

The threshold value is used by the R&S ZVA and R&S ZVT frimware, if electronic power control (via R&S ZVA-B8) is used.

The R&S ZNA doesn't su8pport electronic power control of R&S ZVA-Z90E and R&S ZVA-Z110E.

Meas. Delay Time
Defines the delay time between subsequent sweep points during reference receiver calibration.

In general, the adequate measurement time for a power meter depends on the power level (and possibly also the frequency) and the required measurement precision. For a VDI Erickson power meter, you have to select a "Meas. Delay Time" that corresponds to the response time of the power meter. The lower the power range, the higher the response time. See the PMx manual for details.

Keep in mind that the total time for the reference receiver calibration (step 1) is approximately given as the product of "Sweep Points" and "Meas. Delay Time". At the lowest power range of the PMx, the reference receiver calibration can easily take several tens of minutes, as the response time is in the range of several tens of seconds.

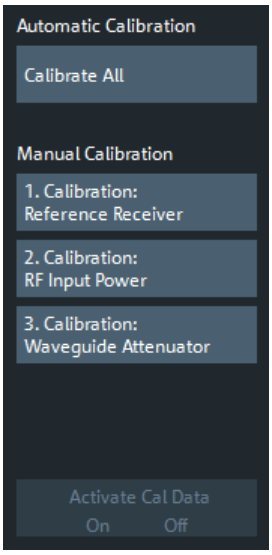
Power sensors of the R&S NRP-Z family, on the other hand, can be queried for the state of the current measurement. The analyzer automatically waits until the power value is stable and "ready for reading" (→ system-determined response time). For these power meters, a positive "Meas. Delay Time" only makes sense, if an *additional* delay on top of the system-determined response time is required.

Load from VNA
Loads the active channel's start frequency, stop frequency, number of sweep points and measurement delay from the analyzer and applies them as "Frequency From", "Frequency To", "Sweep Points" (see "Frequency From/To and Sweep Points" on page 25), and "Meas. Delay Time" on page 25, respectively. Note that this only works if the active VNA channel is configured for a frequency sweep.

Load Default
Resets all leveling settings to their (frequency converter type-specific) defaults.

9.3 Calibration Commands

The buttons on the right hand side of the main window execute the leveling procedure as described in Chapter 2, "Leveling Procedure", on page 6. The leveling can be performed step-by-step ("Manual Calibration") or in one go ("Automatic Calibration").



The manual calibration steps must be performed in ascending order. Requesting manual calibration step M causes the Leveling Tool to execute missing steps 1 to M-1 automatically, preserving the results of steps < M that have already been executed and dropping the results of steps > M.

Automatic calibration always executes all applicable steps.

Automatic Calibration > Calibrate All
Performs calibration steps 1 and 2 in one go.

Manual Calibration > 1. Calibration: Reference Receiver
Performs a reference receiver (a wave) calibration for the related frequency converter port and activates it in the analyzer firmware.

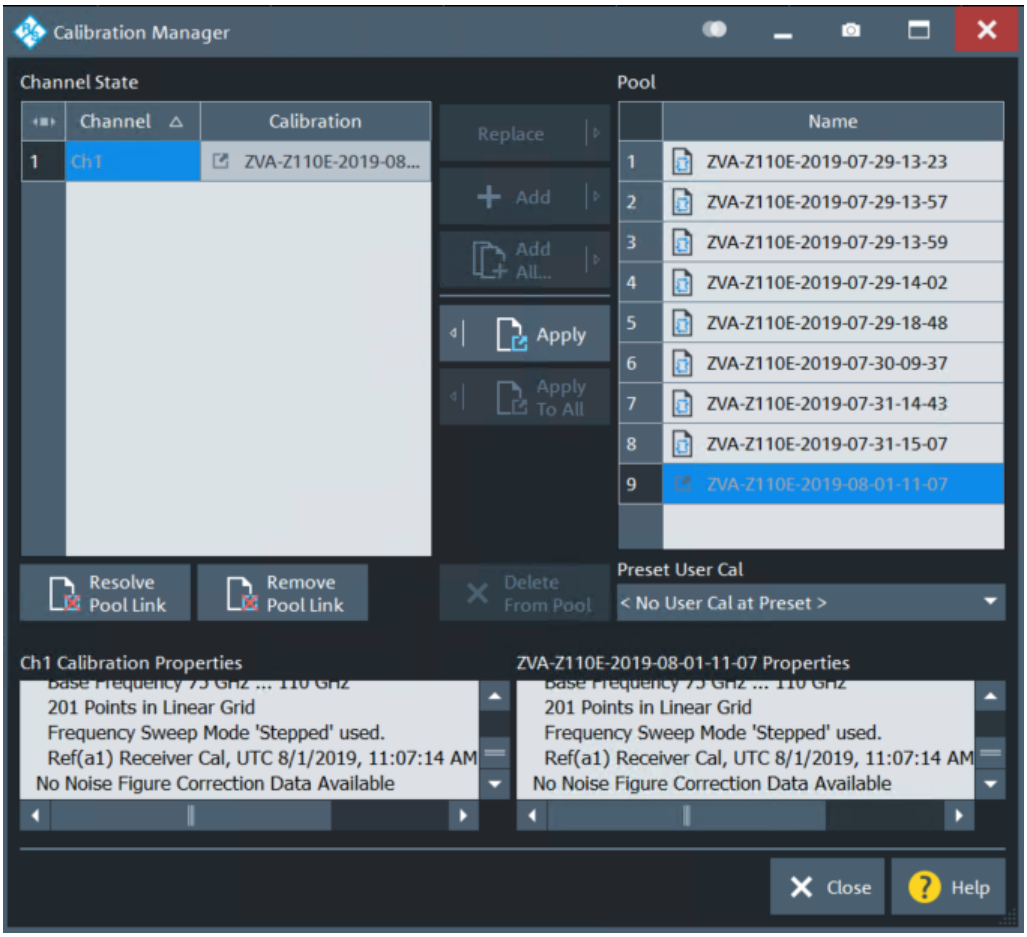


Figure 9-2: Reference receiver calibration (R&S ZNA firmware)

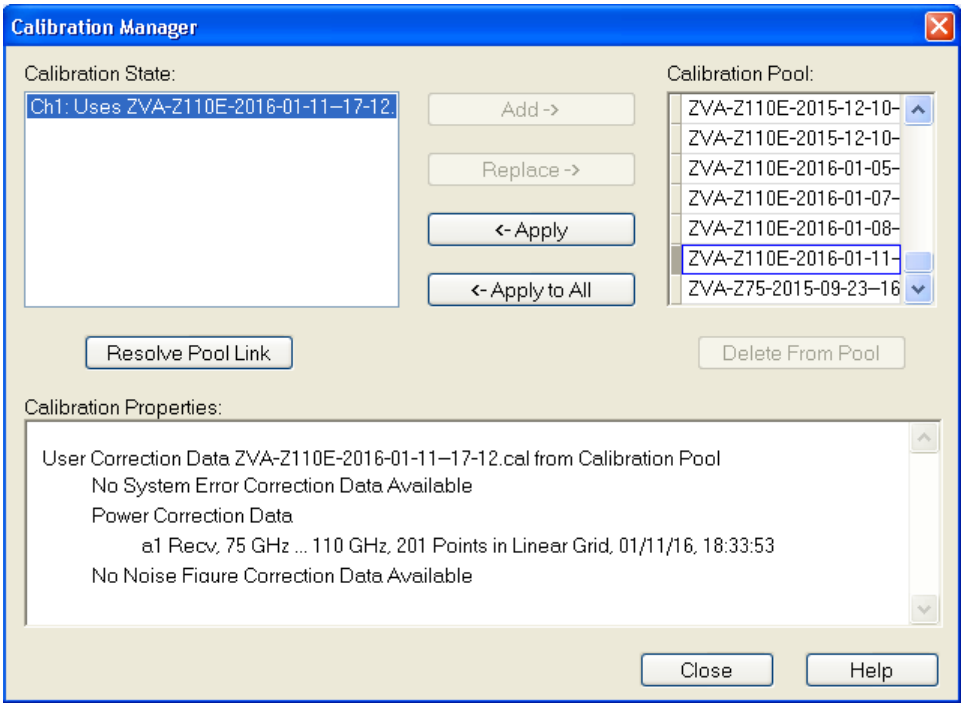
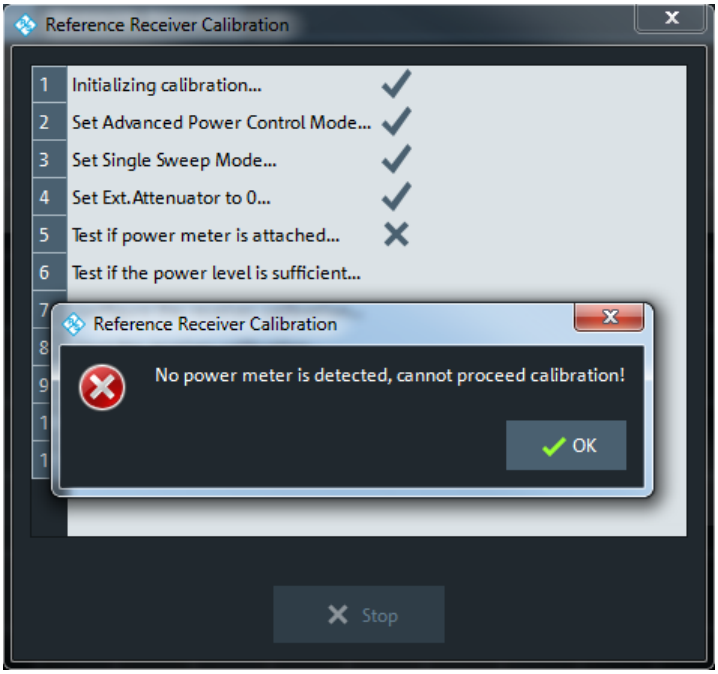


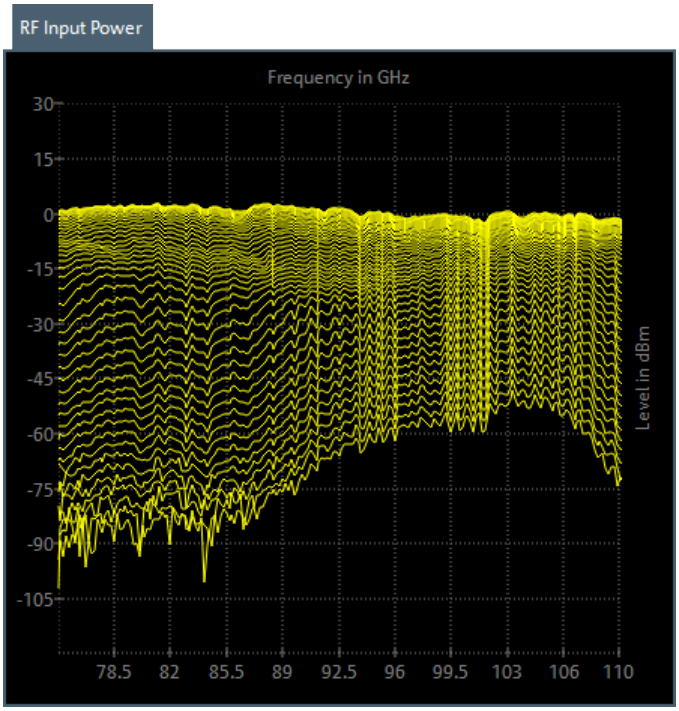
Figure 9-3: Reference Receiver Calibration (R&S ZVA Firmware)

Make sure the power meter is connected to the frequency converter test port before executing this command. Otherwise the following error message is displayed:



Manual Calibration > 2. Calibration: RF Input Power
Records the relation between frequency converter input and output power.

The RF-In level is decreased from "Max. RF-In Level" to "Min. RF-In Level", with steps of "RF-In Level Step Size" (see "Min./Max. RF-In Level and RF-In Level Step Size" on page 25). For each RF-In Level a frequency sweep with the configured Frequency From/To and Sweep Points is performed:

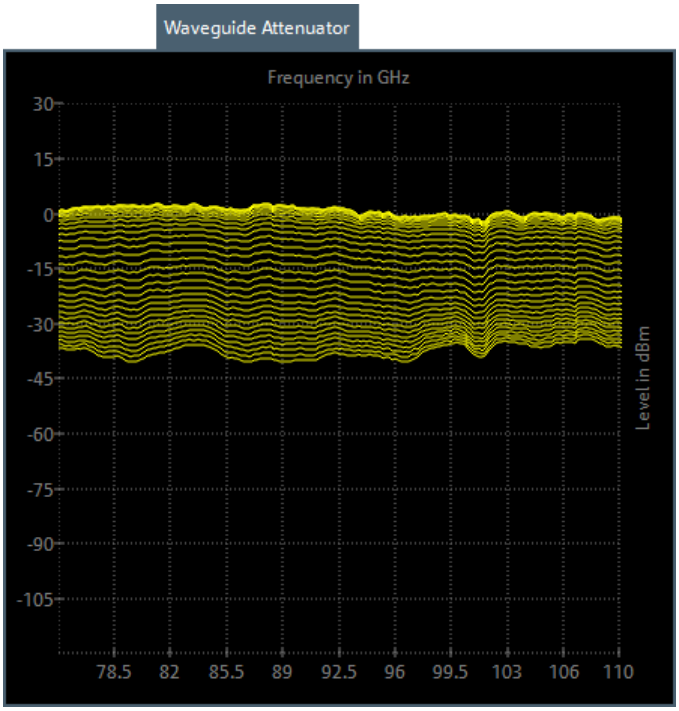


The resulting calibration is stored as frequency converter "User Data Set" on the hard disk of the analyzer but is not activated unless Activate Cal Data is selected.

Because the output is measured via the reference receiver, the power meter is not used during this step.

Manual Calibration > 3. Calibration: Waveguide Attenuator

This step is required for frequency converters with electronic attenuators that are controlled by a R&S ZVA or R&S ZVT via option R&S ZVA-B8 (see Chapter 3, "Required Equipment", on page 8). For all other converter types and driving constellations, it is not available, i.e. the corresponding button is greyed out.



The results are also stored within the frequency converter "User Data Set" created in step 2.

Activate Cal Data
Activates the calibration data obtained in step .

In the **R&S ZNA** firmware, this activates "Power Control" mode "User" for the related frequency converter port, and activates the "Data Set" created by the Leveling Tool.

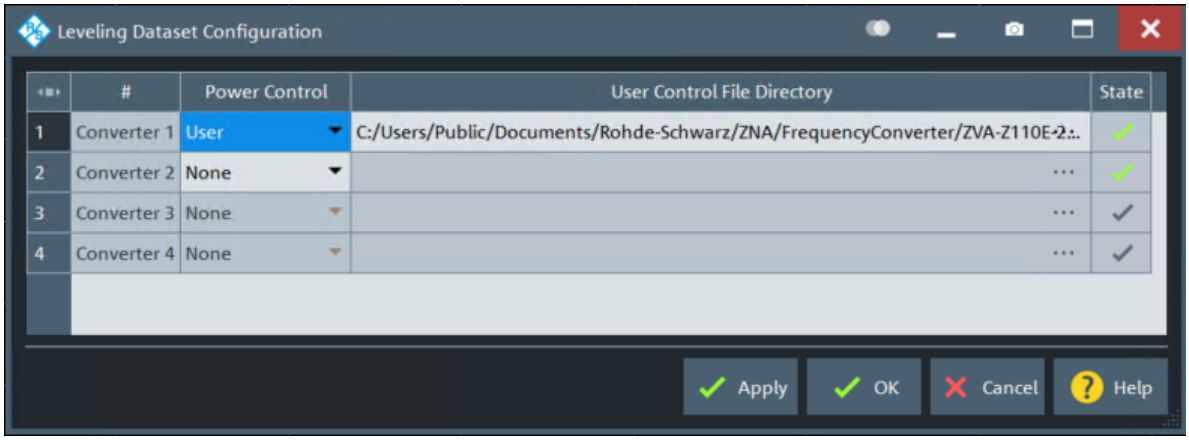


Figure 9-4: Leveling Dataset Configuration

The user data sets are stored in a child directory of `C:\Users\Public\Documents\Rohde-Schwarz\ZNA\FrequencyConverter\`. The directory name is automatically generated using the frequency converter type and the current date and time.

In the **R&S ZVA or R&S ZVT** firmware, this selects control method "RF In Power (and Electronic Attenuator) with Data Set" for the related frequency converter port and activates the "Data Set" created by the Leveling Tool.

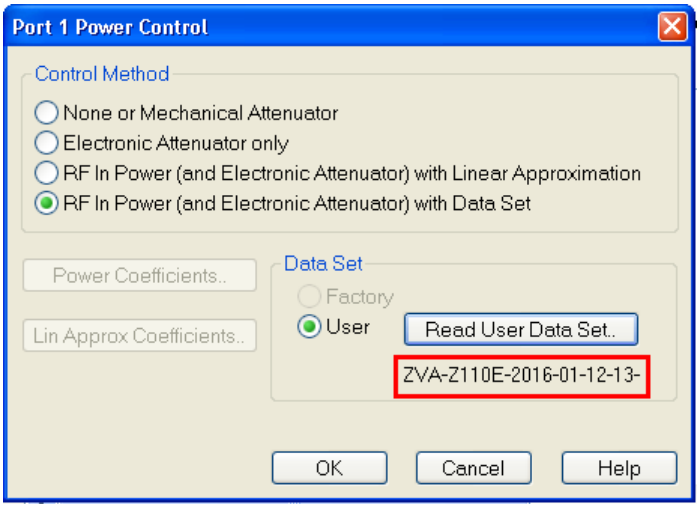


Figure 9-5: Power Control configuration

Here, the user data sets are stored in a child directory of `C:\Rohde&Schwarz\NWA\FrequencyConverter\`. The directory name is automatically generated using the frequency converter type and the current date and time.

9.4 Operating the Leveling Tool

Operation of the Leveling Tool is straightforward. For each frequency converter "Port i " that requires output power leveling, connect the power sensor to the waveguide test port, activate the corresponding tab in the main window of the Leveling Tool and proceed as follows:

1. Select Automatic Calibration > Calibrate All
2. To apply the recorded values, click "Activate Cal Data" in the "Finish" panel of the main window.

Loading the calibration data manually

You can also load previously generated calibration data manually using the analyzer's graphical user interface. This involves two steps:

- **R&S ZNA**:
  - Open the "Leveling Dataset Configuration" dialog (System – [Setup] > "Frequency Converter" > "Leveling Dataset"; see Figure 6-1).
    Select "Power Control" method "User" for the respective converter port, and click the ellipsis button in the "User Control File Directory" to browse for the leveling dataset.
  - Open the "Calibration Manager" dialog (Channel > [Cal] > "Use Cal" > "Cal Manager...").
    Select the recorded receiver calibration from the "Calibration Pool" and apply it to the active channel (see Figure 9-2).
- **R&S ZVA or R&S ZVT:**
  - Open the "Frequency Converter" tab of the "System Configuration" dialog (see Figure 6-1). Click the ellipsis button in the "Power Control" column of the "Port Config" table to open the Power Control dialog (see Figure 9-4). Select "RF In Power (and Electronic Attenuator) with Data Set" and click "Read User Data Set" to load the calibration data.
  - Open the "Calibration Manager" dialog ("Channel > Calibration > Calibration Manager..."). Select the recorded receiver calibration from the "Calibration Pool" and apply it to the active channel (see Figure 9-2).

10 Additional Information

Application notes related to the frequency converters are available for download at https://www.rohde-schwarz.com/application/zvaz. Operating manuals and help systems for network analysis including frequency converters are also available for download; see https://www.rohde-schwarz.com/product/zna.

1. Hiebel, Michael: "Application Note: Multiport Millimeter-Wave Measurements Using Converters of the R&S®ZVA Family", Rohde & Schwarz GmbH & Co. KG, 2007
2. User manual or help system of R&S®ZNA, R&S ZVA and R&S ZVT vector network analyzers, see
   - https://www.rohde-schwarz.com/manual/zna
   - https://www.rohde-schwarz.com/manual/zva
   - https://www.rohde-schwarz.com/manual/zvt
3. R&S®ZCxxx converters Getting Started, see https://www.rohde-schwarz.com/manual/zcxxx
4. R&S®ZVA-Z75/-Z90/-Z110/-Z140/-Z170/-Z220/-Z325/-Z500 and R&S®ZVA-Z90E/-Z110E Quick Start Guides, see https://www.rohde-schwarz.com/manual/zvaz
5. Hiebel, Michael: "Fundamentals of Vector Network Analysis", Rohde & Schwarz GmbH & Co. KG, 4th rev. 2008