Power Calibration of Vector Network Analyzer ZVR

Application Note 1EZ41_2E

Subject to change

10 March 1998, Albert Gleissner

Products:

ZVR, ZVRE, ZVRL

with Option ZVR-B7

ROHDE&SCHWARZ

1 Abstract

The option ZVR-B7 allows an enhanced power calibration of the source and of the receiver channels of a ZVR, then being active instead of the standard factory power calibration. Using an external power meter, the power level of input or output wave quantities will be adjusted to a desired value at an arbitrary reference plane.

2 Introduction

Measuring S-parameters, deviations from the desired power value might be negligible in most cases, as S-parameters are formed by the ratio of the wave quantities. But performing measurements based directly on the absolute power level, a high accuracy of the power levels is required. Examples are mixer, compression and intermodulation point measurements, measurements of active or ferrite containing components. By this point of view, power calibration should be available, if the option ZVR-B4 is used. Corresponding to this need, the ZVR-B7 allows to perform a power calibration of the signal source, the test and reference channels and - furthermore - the calibration of two external sources, needed for mixer or nonlinear measurements.

A source power calibration is carried out in order to keep the level of a wave propagating towards the DUT at a constant value in an arbitrary reference plane, selected by the user. Thus, the frequency response, enhancement or attenuation introduced by the test setup (or DUT) on the power level is eliminated. Typically the plane corresponds to the input of the DUT, but might in special applications also be inside the DUT.

A receiver power calibration is carried out in order to measure the true level of the signals with respect to an arbitrary reference plane.

A power correction is not only effective for the measurement of wave quantities but also for the ratios formed from these quantities.

3 Basic Principle

The option ZVR-B7 allows to calibrate one or more wave quantities in the internal mode:

a_1 (PORT 1), a_2 (PORT 2), b_1 (PORT 1),

b_2 (PORT 2) as well as in the optional external mode: a_1 (OUTPUT a1), b_1 (INPUT b1),

b_2 (INPUT b2) at the corresponding connector or at a reference plane in a transmission line leading to the corresponding connector. A power calibration can only be performed in frequency sweep mode.

3.1 Calibration of the source (a_1, a_2)

Performing a source calibration for the waves a_1 or a_2 (a_2: available for ZVR(E), ZVC(E)), a calibration of the corresponding reference channel is automatically done at each frequency point immediately after the source calibration. As the reference channels are led inside the instrument, no external connections need to be fitted.

A calibration is performed with an external power meter, controlled via the IEC Port II at the rear panel of the ZVR. Its power sensor can be fitted either directly to the test port connector (internal mode: a_1 (PORT 1), see Fig. 1, or a_2 (PORT 2); external mode: a_1 (OUTPUT a1)) or to another reference plane where the measured level should be adjusted to a constant value.

R&S power meters will automatically detect the type of power sensor connected and load the frequency and temperature correction values from the sensor. Thus the calibration factor table is not needed. Before starting a source power calibration, all sweep settings like start and stop frequency, number of points, linear or logarithmic point grid etc. should be made. All settings directly related to the power calibration are entered in the **CAL :** START NEW POWER CAL menu. This includes the configuration of the power meter, the desired source power, the number of iterations at each frequency point and so on.

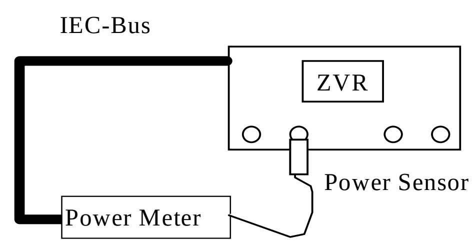


Fig. 1: Test mount for power calibration of port a_1 in internal mode.

Having started a power calibration via the softkey **CAL** : START NEW POWER CAL : TAKE CAL SWEEP, the ZVR controls the calibration procedure. For each frequency point of the sweep, the level at the test port or at the reference plane is measured by the power meter and transmitted to the ZVR. The difference between actual and desired value is calculated, the power of the internal source of the ZVR is increased or decreased by this difference provided that this is compatible with the electronically settable range. This range exceeds the maximum and minimum power available via **SOURCE :** POWER by some dB, depending on the test set installed and on the frequency.

The default value for the desired output power is -10 dBm, it can be modified via **CAL** : START NEW POWER CAL : CAL a1 (a2) POWER. If step attenuation is changed, the attenuation difference is automatically taken into account in the desired output power.

If the deviation between the actual and the desired power is not too big, one correction step might be enough. To eliminate the influence of non linearities of the generator, the number of iterations should be increased when correcting larger deviations (set by **CAL :** START NEW POWER CAL : NUMBER OF READINGS, see ch. 5)

If the desired value of the output power is changed after a generator power calibration and the calibration is not repeated, the correction values are referred to this new value, i. e. the offset between the original and the new desired value is taken into account. The same holds

- if the attenuation of the corresponding source attenuator is changed after a power calibration of the waves a_1 or a_2,
- if the mode is changed from frequency to power sweep,
- if a compression or intercept point measurement is activated.

If the sensor is not directly connected to the test port, and if the power difference between the test port and the reference plane is known as a function of the frequency, this difference can be entered into a list and thus be taken into account

(**CAL :** START NEW POWER CAL ⇨

EDIT(USE) POWER LOSS LIST, see ch. 5)

3.2 Calibration of the receiver (b1, b2)

For a receiver power calibration, a signal from a previously calibrated source of the ZVR is fed into the reference plane to be calibrated.

Internal mode (Fig. 2):
To calibrate b_1 (PORT 1), a_2 (PORT 2) is used
To calibrate b_2 (PORT 2), a_1 (PORT 1) is used.

External mode:

To calibrate b_1 (INPUT b1), a_1 (OUTPUT a1) is used

To calibrate b_2 (INPUT b2), a_1 (OUTPUT a1) is used.

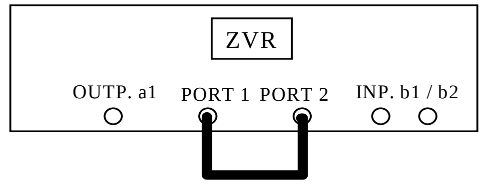


Fig. 2: Connection for power calibration of a receiver channel in internal mode.

Note:

The accuracy of a receiver power calibration depends crucially on the accuracy to which the level of a_1 is known. If higher accuracy is required, a generator power calibration should be performed first.

Similar to the generator power calibration, an offset is taken into account, for a receiver power calibration if the attenuation of the corresponding receiver attenuator is changed.

3.3 Calibrating an external source

The external signal generator to be calibrated as well as a power meter are connected to the IEC Port II at the rear panel of the ZVR. The power sensor of the power meter may be connected directly to the output of the signal generator or to any reference plane in a line connected to this output.

All parameters like type of signal generator, IEC bus address, power, frequency range or number of points maybe set in the menu **CAL :** START NEW POWER CAL ⇨ (*Side Menu)*, see ch. 5. Having started a calibration, the ZVR controls the complete calibration procedure automatically.

4 Components and Instruments

The Rohde & Schwarz **power meters** NRVD, NRVS and NRV are supported. The NRV is an older instrument, which is no longer available. NRVS and NRVD have equal specifications, except that the NRVD offers two separate inputs for power sensors, includes a test generator and SCPI instruction set. As just one sensor channel is needed for a calibration, the NRVS is sufficient. Disregarding the error of the sensors, their accuracy varies from 0.3% +1 digit (at 18°C to 28°C) to 1.3% +1 digit (at 0°C to 50°C).

The Rohde & Schwarz **power sensors** supported by the NRVx power meters are mainly based on two principles:

Thermocouple power sensors measure the average power independent of the signal shape and meet the highest demands on accuracy.

Diode power sensors are more sensitive and faster, but their measurement accuracy is decreased when high-level, non-sinusoidal signals are to be measured.

In the medium sensitivity range it is recomended to use diode power sensors with integrated attenuator, e.g. NRV-Z2. This combination not only allows considerably faster power measurements than a thermal power sensor in the range between 10 µW and 100 µW, it also offers better matching than a highly sensitive thermocouple and still measures true rms power.

A disadvantage might arise from the value of the low frequency limit (ie: NRV-Z2: 10 MHz, NRV-Z5: 100 kHz). For a power calibration down to DC range, the thermocouple sensor NRV-Z51 (DC to 26.5 GHz) can be used. All R&S power sensors provide high accuracy; for exact values see R&S catalogue, p. 217.

The individual frequency response and temperature correction data of the power sensor are stored in an EPROM in the sensor´s connector. In combination with the meter calibration and the auto zero adjustment facility, you may achieve a high degree of accuracy, independent of the choice of the sensor.

The ZVR supports the calibration of the **external sources** of R&S: SME(02)(03)(06), SMG(L)(U), SMH(U), SMP(2)(3)(4)(22), SMT(2)(3)(6), SMY(01)(02) and furthermore of the HP8340A.

For more informations on the instruments, power sensors or power measuring techniques, see hints on literature at the end of this application note.

5 The Softkey Menu

The main menu for a power calibration is opened by pressing

CAL : START NEW POWER CAL.

CAL a1 POWER

This softkey selects power calibration of the source wave a_1. This comprises a power calibration of the internal source and a receiver power calibration of the corresponding reference channel. The reference plane for a_1 lies in a transmission line connected to PORT 1. In external mode, the reference plane for a_1 lies in a line connected to OUTPUT a1. Pressing this key, a data entry field for the desired power at the reference plane is opened. The default value is -10 dBm.

When the power calibration of a_1 or a_2 is started, previous source power correction data for the other wave become invalid. The other wave is then corrected with the data of the calibrated one, which leads to a constant output power at that port only in the special case of both ports having the same frequency response of attenuation. The receiver power correction of the other channel is kept, however.

Note:
If the option ZVR-B6 (Reference Mixer Ports) is fitted and the REFERENCE MIXER softkey is switched on, a correct calibration of a reference channel power is achieved only if the two rear panel sockets RF REF and IF REF are connected by a cable. Otherwise a separate receiver channel calibration for a_1 at the IF REF socket should be carried out (see CAL a1 IF REF POWER softkey).

CAL a2 POWER

This softkey selects power calibration of the wave a_2. This is analogous to the calibration of a_1. The a2 POWER CAL function is not available for the model ZVRL. At the ZVR, a power calibration of the corresponding reference channel is performed automatically. The reference plane for a_2 is located in a transmission line connected to PORT 2 so that the softkey is enabled in the internal mode only.

CAL b1 POWER

This softkey selects receiver power calibration of the wave b_1. For calibration, a power-corrected wave must be fed into the reference plane to be calibrated.

- In the internal mode, a_2 (PORT 2) must be transmitted to a reference plane that is measured by PORT 1.
- In the external mode the reference port for b_1 is connected to the INPUT b1 socket. Therefore, the wave from a_1 (OUTPUT a1) has to be connected to the reference plane of INPUT b1.

CAL b2 INPUT POWER

- This softkey selects receiver power calibration of the wave b_2. This is analogous to the calibration of b_1.

- In the internal mode, the signal from a_1 (PORT 1) must be transmitted to a reference plane that is measured by PORT 2.
- In the external mode, the reference port for b_2 is connected to the INPUT b2 socket. Therefore, the reference from a_1 (OUTPUT b1) has to be connected to the reference plane of INPUT b2.

CAL a1 IF REF POWER

This softkey selects a power calibration of the wave a_1 reference channel via the rear panel connector IF REF. This function requires the option ZVR-B6 (Reference Channel Ports) to be fitted and the Reference Mixer Mode to be switched on **(MODE :** REFERENCE MIXER (on)). The receiver calibration via IF REF is useful especially for frequency-converting group delay measurements with reference mixers where a converted reference signal is received in channel a_1.

The source power corrected wave a_1 is used for calibration. The reference plane of the receiver power calibration is located in a line connected to IF REF.

If the REFERENCE MIXER softkey is switched off after a receiver power calibration for IF REF has been performed, the receiver correction data for the internal signal path of a_1 are used, if available. However, the correction data for IF REF remains valid and is re-activated after switching on the reference mixer mode again.

POWER MTR CONFIG

This softkey calls a table for the configuration of the power meter.

POWER METER CONFIG			
IEC ADDR	TYPE	AUTO ZERO	SENSOR CAL FACTOR
17	R+S NRVD	√	DATA FROM SENSOR

In the IEC ADDR field, the IEC/IEEE bus address of the power meter is entered. It is indicated on the power meter display when switching the instrument on.

When editing the TYPE field, the selection table with NRV, NRVS and NRVD is displayed.

If the AUTO ZERO field is switched on, automatic zeroing of the power meter is performed before each calibration sweep. This is recommended in general and should be performed for small desired levels in any case.

The SENSOR CAL FACTOR field indicates in which way the frequency-dependent calibration factor of the power sensor is taken into account. Due to mismatch, losses and changes in sensitivity of the power sensor, the power measurement is subject to errors. The frequency-dependent calibration factor of a sensor describes the percentage of the input power of the sensor that is actually detected and indicated by the meter. For Rohde & Schwarz power sensors, the calibration factors are taken automatically from the EPROM inside the sensor connector. In this case, the entry DATA FROM SENSOR appears in the field SENSOR CAL FACTOR and can not be edited.

Power meters and sensors from other vendors will be supported in the future. For those meters that do not automatically take the sensor-specific correction data into account, two tables with frequency dependent calibration factors may be defined in the menu SENSOR CAL FACTOR (see in the following).

CAL : START NEW POWER CAL :

SENSOR CAL FACTOR

When a calibration factor list is used, the message FACTOR LIST A (B) depending on the setting of the USE SENSOR A B softkey is indicated (see SENSOR CAL FACTOR menu). A calibration factor of 100 % must then be set at the power meter. For identification of the power sensor, a name can be defined via the SENSOR LABEL softkey. Linear interpolation is applied between the points of the calibration coefficient list. No correction is made in the preset state of the table, i.e., the calibration factor is generally set to 100%.

The DEL ALL POINTS softkey deletes all points from the calibration factor list.

The DEL ACTIVE POINT softkey deletes the active point, ie. the one, selected by the bar.

The INS NEW POINT softkey inserts a new point following the active one. The default values of the new line are adopted by the active point.

The GOTO POINT # softkey renders the indicated point active, i.e., it shifts the selection bar of the calibration factor list vertically into the respective line. The column position of the bar does not change.

The SENSOR LABEL softkey calls the help line editor for the entry of a name for the power sensor which may consist of up to 12 characters.

This name is displayed in the second line of the calibration-factor list and helps to identify the power sensor.

The USE SENSOR A B softkey is used to switch between the calibration factors of the power sensors A and B. The setting of this softkey determines the table displayed and the data set used with power calibration, when the data are not supplied by the sensor itself.

NUMBER OF READINGS

This softkey activates the entry of the number of iteration steps to be made for a power calibration at each test point. The default value is one.

An iteration step consists of measuring the actual power at the reference plane with the power meter. Then, the difference between the desired and the actual power is determined and the power of the generator to be calibrated is increased or decreased by this difference – provided that this is compatible with the allowed setting range.

The smaller the deviation of the actual power from the desired value is, the higher is the power accuracy which can be obtained in one step. With high deviations, adjustment in one step might not achieve full accuracy. This is due to nonlinearities of the generator. 2 or 3 steps, however, should be sufficient in nearly all cases.

TAKE CAL SWEEP

This softkey starts a single power calibration sweep in the active display channel.

⇨ **Side Menu**

CAL EXT SRC1 POWER

This softkey selects a source power calibration of the external signal source 1. An entry field for the desired level is opened simultaneously. The frequency range of this calibration is defined via DEF SRC 1 PCAL SWEEP. As soon a generator is defined as SRC 1 via EXT SRC CONFIG and GPIB handshake has occured, this key will be available.

DEF SRC 1 PCAL SWEEP

This softkey involves the table SRC 1 PCAL SWEEP which is used to define the frequency points for the source power calibration of the external source 1. As soon as a generator is defined as SRC 1 via EXT SRC CONFIG and GPIB handshake has occured, this key will be available.

SRC 1 POWER CAL SWEEP	
START	10 MHz
STOP	3 GHz
NUM OF PTS	100
SWEEP GRID	LIN

*

CAL EXT SRC2 POWER

This softkey selects a source power calibration of the external signal source 2. This is analogous to the calibration of the external source 1 (see EXT SRC 1 POWER CAL softkey). As soon as an instrument is defined as SRC 2 with EXT SRC CONFIG and GPIB handshake has occured, this key will be activated.

DEF SRC 2 PCAL SWEEP

This softkey involves the table SRC 2 PCAL SWEEP which is used to define the frequency points for the source power calibration of the external source 2. This is analogous to the definition of the frequency points for the external source 1 (see DEF SRC 1 PCAL SWEEP softkey). As soon as an instrument is defined as SRC 2 with EXT SRC CONFIG and GPIB handshake has occured, this key will be activated.

EXT SRC CONFIG

This softkey involves the EXT SOURCES CONFIG table. For both external sources (SRC1, SRC2), the type of communication (REMOTE), the IEC bus address (IEC ADDR) and the type of the signal generator (TYPE) may be defined.

EXT SOURCES CONFIG			
SRC	REMOTE	IEC ADDR	TYPE
1	GPIB	28	SME06
2	OFF	19	

REMOTE:

Switching this field to OFF, the GPIB interface is deactivated. GPIB sets the IEC bus communication with the signal generator active. GPIB+TTL uses the IEC bus as well as the signals MARKER (input), BLANK (input) and TRIGGER (output) at the rear panel of the ZVR and of the external signal generator. Using this mode, the list of frequency points is loaded into the signal generator at the beginning of the calibration procedure. By setting the BLANK signal low, the generator indicates that the next frequency and power have not yet settled. Measurement does not start until the BLANK signal has changed to high. During the calibration, high and low level of the MARKER´s TTL signal indicate, if the signal generator is going backward or forward in frequency, respectively. TRIGGER is used to switch the generator to the next frequency. The GPIB+TTL mode accelerates a calibration sweep considerably.

IEC ADDR: Enter the IEC bus address of the signal generator. It is indicated when booting the instrument or may be seen from the instrument menu.

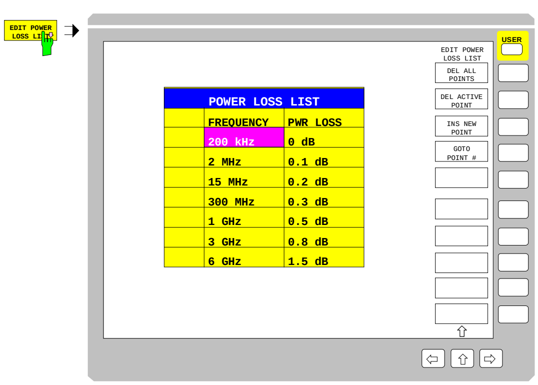
TYPE : Choose the type of your signal generator. For a list of instruments supported, edit the list of instruments or see chapter 4, components and instruments.

USE POWER LOSS LIST

This softkey activates a known, frequency-dependent power loss list. Sometimes it is not possible to connect the power sensor directly at the reference plane for source power calibration, i.e. if an attenuator has to be used to protect the power sensor. If, however, the level difference between the reference port and the actual measurement plane of the sensor is known and stored in the power loss list, a generator power calibration can nevertheless be performed. The power loss value from the list is then added to the measured power. If required, interpolation over the frequency is carried out automatically.

EDIT POWER LOSS LIST

In this menu, the values of the power loss list are entered. The EDIT POWER LOSS LIST softkey calls a submenu that allows to enter the frequency-dependent loss between the reference plane and the actual sensor measurement plane.



Up to 20 frequency points can be entered into the POWER LOSS LIST. The entries are sorted in ascending order of the frequencies. Besides the point number, there are two columns that can be edited:

FREQUENCY: Frequency value of the point.

PWR LOSS: Associated loss in dB

Linear interpolation is applied between the points of the loss list. The preset state of the table does not include any correction, i.e., the losses are assumed to be 0 dB.

The DEL ALL POINTS softkey deletes all points from the power loss list.

The DEL ACTIVE POINT softkey deletes the active point, i.e. that is indicated by the selection bar.

The INS NEW POINT softkey inserts a new point following the active one.

The default values of the new line are adopted by the active point.

The GOTO POINT # softkey renders the indicated point active, i.e., it shifts the selection bar of the loss list vertically into the respective line. The column position of the cursor does not change.

CAL :

POWER UNCAL

This softkey switches power correction off and on. Power correction is a setting which can be coupled, i. e. it affects exclusively the active display channel when the channels are decoupled. Active power correction is indicated by the enhancement label PC(x).

Some additional instrument settings are stored together with the power correction data. Upon switching on power correction, those settings are restored in order to guarantee the consistency of correction data and instrument settings.

When **CAL :** POWER UNCAL is active, a power correction is still performed with factory-set correction data. The level measured for a wave is referred to the instrument connectors which are currently in use. In the internal mode (**MODE :** EXTERNAL (off)) these are the test ports PORT 1 and PORT 2. In the external mode these are the OUTPUT a1, INPUT b1 and INPUT b2 connectors. If the option ZVR-B6 is fitted and **MODE :** REFERENCE MIXER is on, the input level measured for a_1 is referred to the IF REF connector on the rear panel of the instrument.

6 Performing a Calibration

Summarising the previous description, this section gives concrete instructions how to perform a calibration.

6.1 Source Power Calibration

1. To calibrate a_1 at PORT 1 (internal mode), connect the power meter to the IEC II port at the rear panel of the ZVR and the power sensor to PORT 1.
2. Set START and STOP frequency (main menu STIMULUS) and the number of points (main menu SWEEP)
3. Configure the instrument by entering **CAL :** START NEW POWER CAL : POWER MTR CONFIG.
4. Press CAL a1 POWER and enter the desired power level.
5. Set NUMBER OF READINGS to an appropriate value depending on the initial difference between actual and desired power and the desired accuracy.
6. Press TAKE CAL SWEEP to start the calibration.

For a calibration of a_2 (internal mode), just select a_2 and PORT 2 in step 1 and 4.

In the optional external measurement mode, select a_1 and OUTPUT a1 in step 1.

6.2 Receiver Power Calibration

1. To calibrate b2 (internal mode), first perform a power calibration of a1 at PORT 1 (see previous section).
2. Connect PORT 1 to PORT 2 using a low loss cable.
3. Press CAL b2 POWER.
4. Start calibration by TAKE CAL SWEEP.

To calibrate b_1 (internal mode), first perform a calibration of a_2 (PORT 2) and feed PORT 1 from a_2.

For a power calibration of the external input channels INPUT b1 and INPUT b2, perform a calibration of a_1 (OUTPUT a1) first and feed INPUT b1 or INPUT b2 from OUTPUT a_1.

6.3 Signal Generator Power Calibration

1. Connect the power meter as well as the signal generator to the IEC II port at the rear panel of the ZVR and the power sensor to the output of the signal generator.
2. Configure the power meter.
   CAL : START NEW POWER CAL :
   POWER METER CONFIG
3. Configure the signal generator
   CAL : START NEW POWER CAL :
   ⇨ : EXT SRC CONFIG.
4. Define the sweep parameters using the softkeys
   CAL : START NEW POWER CAL : ⇨ :
   CAL EXT SRC1(2) POWER and
   DEF SRC 1(2) PCAL SWEEP.
5. Go back to the main menu (⇦), start calibration with TAKE CAL SWEEP.

7 Help on Errors & Hints

Depending on the test set (50 Ω or 75 Ω and on frequency, the minimum and maximum power available from the internal generator exceeds the range that can be set by the user via the **SOURCE** : POWER softkey by some dB. Without power calibration, the deviation is

<0.5 dB at -10 dBm.

Table 1 gives power accuracy data for the ZVR instruments with active power calibration at the desired level.

Frequency	Deviation after power calibration of generator 1) 3)	Deviation after power calibration of receiver 2) 3)
10 Hz ... 2 MHz	0.2 dB	0.25 dB
2 MHz ... 4 GHz	0.1 dB	0.15 dB

Table 1: Typical power accuracy of the ZVR after power calibration.

1) Maximum deviation from desired value of output power a_1 and a_2 after power calibration.

2) Maximum deviation from desired value of input power b_1 and b_2 after power calibration. For the calibration of b_1 and b_2, the calibrated a_1 or a_2 signals were used. By this way, the deviation of b_1 or b_2 consists of the deviation of a_1 and the measurement uncertainty of the receiver. Measuring power levels different from the desired value, additional linearity errors contribute to the deviation.

3) Measurement uncertainties of the power calibration source are not taken into account as this may vary between different instruments and power sensors. Accepting worst case, this uncertainty must be added to the deviations indicated above.
The values for measurement uncertainties don´t take into account the influence of multiple reflections, caused by mismatch.

- After the calibration sweeps have been carried out successfully, the correction data are stored in a file so that they are still available after switching off and on the instrument.
- A power calibration can not be started when
  - the current sweep mode is not a frequency sweep,
  - a frequency converting or
- nonlinear measurement mode is active. However, a power correction can then still be active.
- Only one power calibration data set may be defined, either for internal or external mode. A power calibration will be switched off(on) by switchover between internal and external mode or by increasing the frequency range in excess to the calibrated range. Setting **CAL :** POWER UNCAL (on), the instrument automatically changes to the mode, the power calibration was performed in. Once switched off, the power calibration may be be set active manually by **CAL :** POWER UNCAL (on).
- The source and receiver frequencies are also influenced by switching on and off or modifying a frequency-converting or non-linear measurement mode. Correction data for waves and for external generators are switched on and off together, although the corresponding point grids may be different.
- If a generator step attenuator is available, its attenuation should be selected before the calibration is started so that the level range that can be set electronically covers the frequency response to be corrected.
- Power correction with an offset improves the accuracy of the desired power because of possible deviations from linearity in the generator power and, eventually, in the signal path. The maximum offset is given by the power range of the respective source. To achieve full accuracy, the desired level must not be changed after calibration.
- To achieve maximum accuracy, thermal stability must be provided. The ZVR should warm up for at least 1 - 2 hours. The environment temperature should not change by more than 1° between calibration and measurement. The time delay between calibration and measurement should not exceed 30 minutes.
- To achieve maximum accuracy, the frequency range should not be changed - even to a smaller range - as interpolation is used if the test point grid does not match. Maximum accuracy is guaranteed just if the enhancement label PC is indicated.

The frequency range used for a power calibration, is selected by the main menu softkeys START (STOP) or CENTER (SPAN). The number of frequency points in this interval is defined by **SWEEP :** NUMBER OF POINTS : (*enter nr. of points*)

Enhancement Labels

The enhancement label PC indicates that power calibration is active:

PC	power correction of at least one wave quantity
PCi	interpolation of the correction data over frequency
PCo	an offset with respect to the original correction data is taken into account
PC?	for a generator power calibration of the internal signal source, either the desired level could not be reached for at least one test point, or the power range of the source is exceeded

Below the enhancement label PC(x), all waves with valid correction data are indicated (a_1, a_2, b_1, b_2). External mode is indicated by the enhancement label EXT. If a receive power calibration for the wave a_1 with respect to the reference mixer port IF REF is active, an additional I is displayed in the corresponding line.

8 Literature

- R&S´s WebSite
  http://www.rsd.de
  ⇒ Products
  ⇒ Test and Measurement
  ⇒ Voltage and power measurements
- R&S Catalogue, ch. 7.
- R&S brochure on power measurement (PD 757.0835.12)

Albert Gleissner, 1ESP
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10 March 1998

9 Further Application Notes

[1] O. Ostwald: 3-Port Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ26_1E.

[2] H.-G. Krekels: Automatic Calibration of Vector Network Analyzer ZVR, Appl. Note 1EZ30_1E.

[3] O. Ostwald: 4-Port Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ25_1E.

[4] T. Bednorz: Measurement Uncertainties for Vector Network Analysis, Appl. Note 1EZ29_1E.

[5] P. Kraus: Measurements on Frequency-Converting DUTs using Vector Network Analyzer ZVR, Appl. Note 1EZ32_1E.

[6] J. Ganzert: Accessing Measurement Data and Controlling the Vector Network Analyzer via DDE, Appl. Note 1EZ33_1E.

[7] J. Ganzert: File Transfer between Analyzers FSE or ZVR and PC using MS-DOS Interlink, Appl. Note 1EZ34_1E.

[8] O. Ostwald: Group and Phase Delay Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ35_1E.

[9] O. Ostwald: Multiport Measurements using Vector Network Analyzer, Appl. Note 1EZ37_1E.

[10] O. Ostwald: Frequently Asked Questions about Vector Network Analyzer ZVR, Appl. Note 1EZ38_3E.

[11] A. Gleißner: Internal Data Transfer between Windows 3.1 / Excel and Vector Network Analyzer ZVR, Appl. Note 1EZ39_1E.

[12] A. Gleißner: Power Calibration of Vector Network Analyzer ZVR, Appl. Note 1EZ41_2E

[13] O. Ostwald: Pulsed Measurements on GSM Amplifier SMD ICs with Vector Analyzer ZVR, Appl. Note 1EZ42_1E.

[14] O. Ostwald: Zeitbereichsmessungen mit dem Netzwerkanalysator ZVR, Appl. Note 1EZ44_1D.

10 Ordering Information

Order designation	Type	Frequency range	Order No.
Vector Network Analyzers (test sets included) *			
3-channel, unidirectional, 50 Ω, passive	ZVRL	9 kHz to 4 GHz	1043.0009.41
3-channel, bidirectional, 50 Ω, passive	ZVRE	9 kHz to 4 GHz	1043.0009.51
3-channel, bidirectional, 50 Ω, active	ZVRE	300 kHz to 4 GHz	1043.0009.52
4-channel, bidirectional, 50 Ω, passive	ZVR	9 kHz to 4 GHz	1043.0009.61
4-channel, bidirectional, 50 Ω, active	ZVR	300 kHz to 4 GHz	1043.0009.62
3-channel, bidirectional, 50 Ω, active	ZVCE	20 kHz to 8 GHz	1106.9020.50
4-channel, bidirectional, 50 Ω, active	ZVC	20 kHz to 8 GHz	1106.9020.60
Alternative Test Sets *			
75 Ω SWR Bridge for ZVRL (instead of 50 Ω) 1)			
75 Ω, passive	ZVR-A71	9 kHz to 4 GHz	1043.7690.18
75 Ω SWR Bridge Pairs for ZVRE and ZVR (instead of 50 Ω) 1)			
75 Ω, passive	ZVR-A75	9 kHz to 4 GHz	1043.7755.28
75 Ω, active	ZVR-A76	300 kHz to 4 GHz	1043.7755.29
Options			
AutoKal	ZVR-B1	0 to 8 GHz	1044.0625.02
Time Domain	ZVR-B2	same as analyzer	1044.1009.02
Mixer Measurements 2)	ZVR-B4	same as analyzer	1044.1215.02
Reference Channel Ports	ZVR-B6	same as analyzer	1044.1415.02
Power Calibration 3)	ZVR-B7	same as analyzer	1044.1544.02
3-Port Adapter	ZVR-B8	0 to 4 GHz	1086.0000.02
Virtual Embedding Networks 4)	ZVR-K9	same as analyzer	1106.8830.02
4-Port Adapter (2xSPDT)	ZVR-B14	0 to 4 GHz	1106.7510.02
4-Port Adapter (SP3T)	ZVR-B14	0 to 4 GHz	1106.7510.03
Controller (German) 5)	ZVR-B15	-	1044.0290.02
Controller (English) 5)	ZVR-B15	-	1044.0290.03
Ethernet BNC for ZVR-B15	FSE-B16	-	1073.5973.02
Ethernet AUI for ZVR-B15	FSE-B16	-	1073.5973.03
IEC/IEEE-Bus Interface for ZVR-B15	FSE-B17	-	1066.4017.02
Generator Step Attenuator PORT 1	ZVR-B21	same as analyzer	1044.0025.11
Generator Step Attenuator PORT 2 6)	ZVR-B22	same as analyzer	1044.0025.21
Receiver Step Attenuator PORT 1	ZVR-B23	same as analyzer	1044.0025.12
Receiver Step Attenuator PORT 2	ZVR-B24	same as analyzer	1044.0025.22
External Measurements, 50 Ω 7)	ZVR-B25	10 Hz to 4 GHz (ZVR/E/L) 20 kHz to 8 GHz (ZVC/E)	1044.0460.02

1) To be ordered together with the analyzer.
2) Harmonics measurements included.
3) Power meter and sensor required.
4) Only for ZVR or ZVC with ZVR-B15.
5) DOS, Windows 3.11, keyboard and mouse included.
6) For ZVR or ZVC only.
7) Step attenuators required.

*** Note:**
Active test sets, in contrast to passive test sets, comprise internal bias networks, eg to supply DUTs.