

Multi-port calibration by using a two port calibration unit

Application Note

Products:

- R&S®ZVA
- R&S®ZNB
- R&S®ZVT

Performing a multi-port calibration of a vector network analyzer (VNA) is straight forward by using either a calibration unit with the corresponding numbers of ports or single calibration standards.

This paper shows how to perform a n-port multi-port calibration by using calibration unit with a lower number of ports than available of the vector network analyzer.



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1 Introduction

The system error correction (SEC) calibration is a fundamental step in using a vector network analyzer (VNA). In particular for multi-port measurement with a higher number of ports, it is highly recommended to use a calibration unit instead of single calibration standards to reduce the time and to avoid manually operating mistakes. The purpose of this paper is to illustrate how to perform a multi-port calibration by using a calibration unit with less numbers of ports than VNA test ports.

The pictures below show fundamental examples of multi-port calibration applications. Figure 1-1 shows a four-port VNA and Figure 1-2 shows a two-port VNA connected to a 16 port switch matrix. Both VNAs have to be calibrated by e.g. a two port calibration unit.



Fig. 1-1: Four port R&S®ZVA

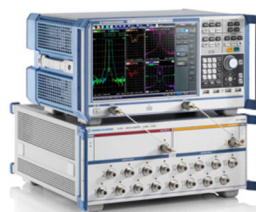


Fig. 1-2: Two port R&S®ZNB + switch matrix

To perform a full n-port calibration by a calibration unit with a lower number of ports, it is obvious that the calibration unit has to get connected to each physical port of the VNA. The vector network analyzer provides an optimized connection proposal to reduce the number of THRU connections. Hence, the required number of reconnections will also be reduced. Instead of measuring the THRU connection between each individual port, the error correction data of the missing transmissions are calculated based on the available system error correction data.

In case that the recommended connection procedure is not suitable for the used application, of course it is possible to change the connection sequence manually. The ZVA also allows adding and deleting of additional assignments whereas at the ZNB, the proposed number of connections cannot be changed.

The total number of connections is related on the used ports of the vector network analyzer, the ports of the calibration unit and the selected calibration type.

For a segmented sweep, the n-port calibration procedure includes each segment. It is not necessary to calibrate the segments individually.

The number of ports which can be calibrated e.g. by a two port calibration unit is only limited by the physical ports of the vector network analyzer or the connected switch matrix. The support of the switch matrix is only available on the R&SZNB and requires firmware version up from 1.7.

2 Multi-port calibration steps

The calibration process is described by the following steps:

- Set up of stimulus data and sweep settings
- Open the Calibration menu
- Select the used ports and calibration type
- Set the connection sequence
- Perform the calibration including reconnection of the calibration unit

The following sections show a step-by-step instruction of the R&S®ZVA and R&S®ZNB. In the examples, a four-port vector network analyzer has to be calibrated by a two-port calibration unit. In case of a higher number of ports, the number of connections will be increased but the procedure works similar.

2.1 Using the R&S®ZVA with multi-port calibration

► Set up of stimulus data and sweep settings



Channel > Stimulus > Start Frequency...

Channel > Stimulus > Stop Frequency...

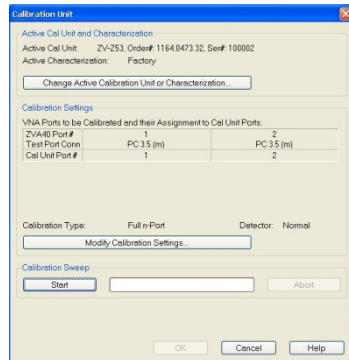
Channel > Stimulus > Power...

Channel > Sweep > Number of Points...

Instead of number of points, it is possible to use

Channel > Sweep > Frequency Step Size...

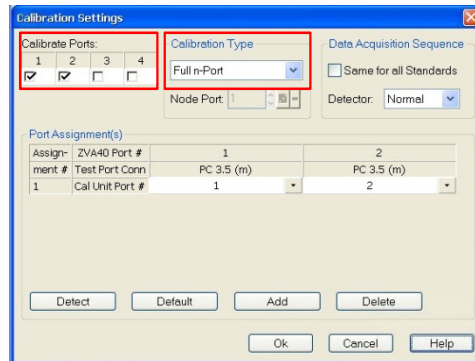
► Open the calibration menu



Channel > Calibration > Start Cal > Calibration Unit...

The ZVA performs an auto detection to detect the assignment of VNA ports to the calibration unit. The input power into the calibration unit has to be at least -40 dBm to ensure a correct result of the auto detection algorithm. If the result is incorrect, the connections should be verified and the ports have to be assigned manually.

► Select the used ports and calibration type

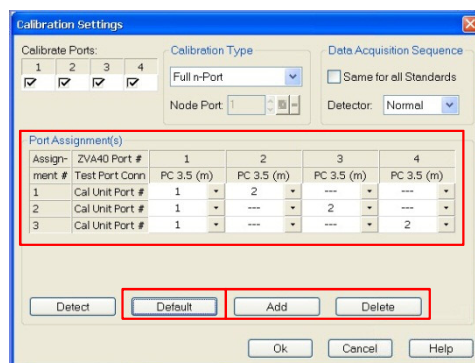


Press the **Modify Calibration Settings...** button

The affected ports have to be selected, e.g. port 1 and 2.

Select the **Calibration Type**

► Set the connection sequence

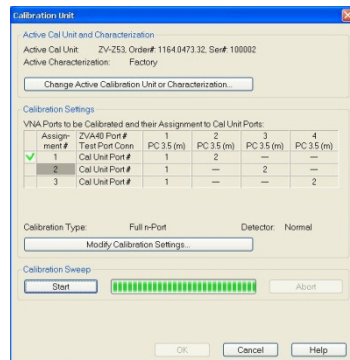


Press the **Default** button

The vector network analyzer creates an optimized connection sequence to ensure the minimum number of connections to perform a precise calibration.

To set up a connection sequence manually, those assignments can be created by the **Add** button and deleted by the **Delete** Button.

- Perform the calibration including reconnection of the calibration unit



Press the **Start** button

The table shows the current status of connection sequence.

If a calibration step is finished, the software displays a green checkmark. The next connection has to be set up and the **Start** button has to be pressed again.

2.2 Using the R&S®ZNB with multi-port calibration

- Set up of stimulus sweep settings



Channel > Stimulus > Start
Frequency...

Channel > Stimulus > Stop
Frequency...

Channel > Stimulus > Power
Bandwidth Average > Power...

Channel > Sweep > Number of Points...

- Open the calibration menu



**Channel > Start Cal >
Start Cal...(Cal Unit)**

The ZNB performs an auto detection to get the assignment of VNA ports to the calibration unit.

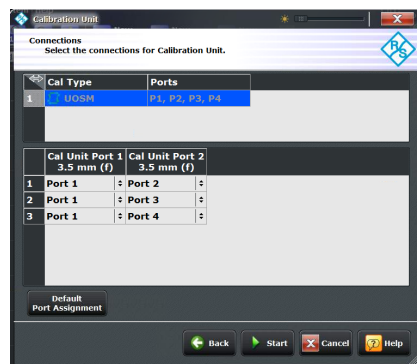
If the result is incorrect, the connections should be verified and the ports have to be assigned manually. Like with the ZVA, the input power into the calibration has to be min. -40 dBm to ensure a correct result of the auto detection algorithm.

- Select the used ports and the calibration type



Select the used ports by using the ZNB touchscreen and choose the calibration type.

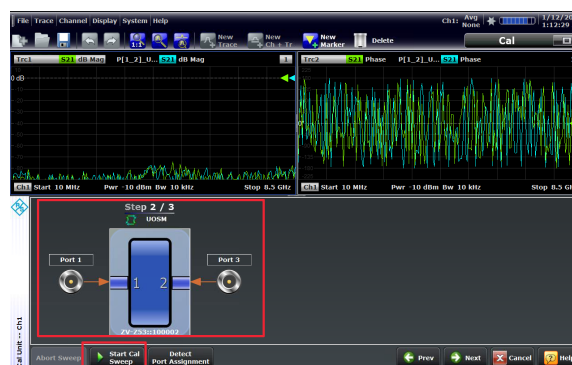
- Set the connection sequence



The ZNB creates an optimized connection sequence to ensure the minimum number of connection to perform a precise calibration.

The order can be changed manually but in difference to the ZVA, the number of steps is fixed and cannot be increased.

- Perform the calibration including reconnection of the calibration unit



The picture shows which VNA port has to get connected to the calibration unit.

Press the **Start Cal Sweep** button

After the next connection, the **Start Cal Sweep** button starts the next calibration step.

3 Ordering Information

Designation	Type	Order No.
Vector Network Analyzers		
300 kHz - 8 GHz, 4 Ports	R&S®ZVA8	1145.1110.10
10 MHz - 24 GHz, 4 Ports	R&S®ZVA24	1145.1110.26
10 MHz - 40 GHz, 4 Ports	R&S®ZVA40	1145.1110.42
10 MHz - 50 GHz, 4 Ports	R&S®ZVA50	1145.1110.52
10 MHz - 67 GHz, 4 Ports	R&S®ZVA67	1312.7002.04
9 kHz - 4.5 GHz, 4 Ports	R&S®ZNB4	1311.6010.24
9 kHz - 8.5 GHz, 4 Ports	R&S®ZNB8	1311.6010.44
300 kHz - 8 GHz, up to 8 Ports	R&S®ZVT8	1300.0000.08
10 MHz - 20 GHz, up to 6 Ports	R&S®ZVT20	1300.0000.20
Calibration Units:		
300 kHz to 8 GHz, Four Ports, 3.5 mm (f)	R&S®ZV-Z51	1164.0515.30
300 kHz to 8 GHz, Four Ports, N (f)	R&S®ZV-Z51	1164.0515.70
10 MHz to 24 GHz, Four Ports, 3.5 mm (f)	R&S®ZV-Z52	1164.0521.30
300 kHz to 18 GHz, Four Ports, N (f)	R&S®ZV-Z53	1164.0473.72
300 kHz to 24 GHz, Two Ports, 3.5 mm (f)	R&S®ZV-Z53	1164.0473.32
10 MHz - 40 GHz, 2 Ports, 2.92mm (f)	R&S®ZV-Z54	1164.0467.92
300 kHz - 8 GHz, 8 Ports, N (f)	R&S®ZV-Z58	1164.0638.78
10 MHz - 20 GHz, 6 Ports, 3.5 mm (f)	R&S®ZV-Z59	1164.0450.36
Switch Matrix		
50 MHz - 24 GHz, 2 to 5 Ports, 2.92 mm (f)	R&S®ZV-Z81	5200.6790.05
50 MHz - 24 GHz, 2 to 9 Ports, 2.92 mm (f)	R&S®ZV-Z81	5200.6790.09
50 MHz - 24 GHz, 2 to 16 Ports, N (f)	R&S®ZV-Z81	5200.6790.66
50 MHz - 24 GHz, 4 to 10 Ports, 2.92 mm (f)	R&S®ZV-Z82	5200.6860.10

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Environmental commitment

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- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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