Measurement of the Phase Difference between several Signals
Application Note

Products:

- R&S®ZNB
- R&S®ZNBT
- R&S®ZNA

Many applications in aerospace and defense as well as in mobile communication require a defined magnitude and phase relation between several signals, for example, to design a smart antenna array and it's distribution network, or to ensure accurate phase alignment between different transmitter or receiver chains of T/R modules. Magnitude can be measured with spectrum analyzers or power meters. For phase measurements, a vector network analyzer is the easiest, fastest and most accurate instrument.

This application note shows how to measure the phase accurately between several signals using vector network analyzers of the R&S®ZNA, R&S®ZNB and R&S®ZNBT families.

Note:

Please find up to date document on our homepage
http://www.rohde-schwarz.com/appnote/1EZ82

Application Note

Thilo Bednorz

1.2019 - 1EZ82

ROHDE&SCHWARZ

Table of Contents

1 Abstract

The basic function of a vector network analyzer (VNA) is to measure S-parameters according to magnitude and phase. To accomplish these measurements, a VNA consists of one or more generators and typically two coherent selective receivers for each test port. Therefore, a VNA can be used as a multiple receiver system to measure the phase between several signals.

2 The Setup

2.1 Block diagram of vector network analyzer

A VNA can not only be used to measure S-parameters but also as a multiple receiver system. There are two receivers for each test port: a measurement receiver and a reference receiver that share a common local oscillator.

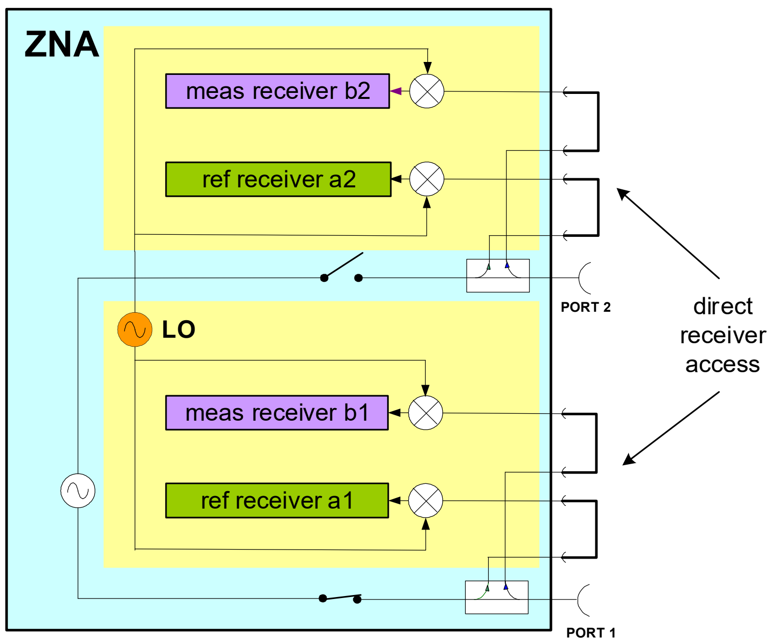


Fig. 2-1: Block diagram of a VNA with direct receiver access (two-port R&S®ZNA)

Signals applied to port 1 and port 2 are detected by the measurement receivers b1 and b2 and the complex ratio is analyzed according to magnitude and phase. The R&S®ZNA family offer as an option direct source and receiver access (option R&S®ZNA-B16). The direct receiver access feeds the measurement and reference signal from the directional coupler via loops to the front panel and back to the receivers. These loops can be removed, providing access all the analyzer's receivers. Thus a two-port R&S®ZNA can analyze four signals. A four-port R&S®ZNA includes eight receivers and can analyze eight signals.

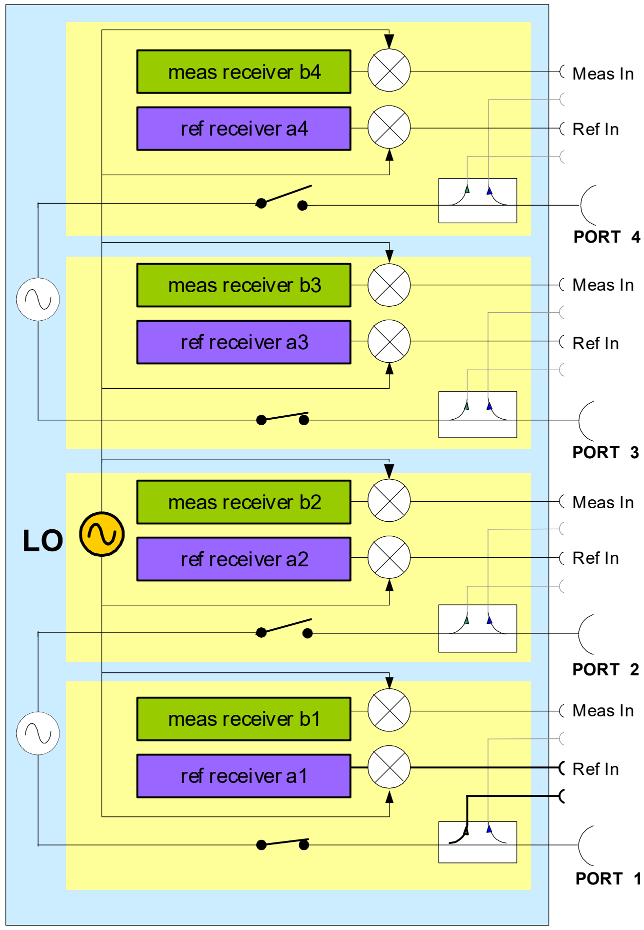


Fig. 2-2: Block diagram of a four-port R&S®ZNA

2.2 Measurement of the phase between two signals

Measuring the phase between two signals, when the DUT is not stimulated by the VNA requires a two-port vector network analyzer like the R&S®ZNA or the R&S®ZNB without any additional options. Both signals are directly connected to the test ports of the analyzer. To avoid interference caused by the internal source, which is coupled via the bridge or coupler to the receivers of R&S®ZNA or R&S®ZNB, the power of the source has to be switched off. For weak signals **below -30 dBm maximum** source step attenuation should be applied as well if the options installed to reduce the analyzer's power furthermore. When using the direct receiver access with an R&S®ZNA it is not necessary to switch off the source, or to apply source step attenuation.

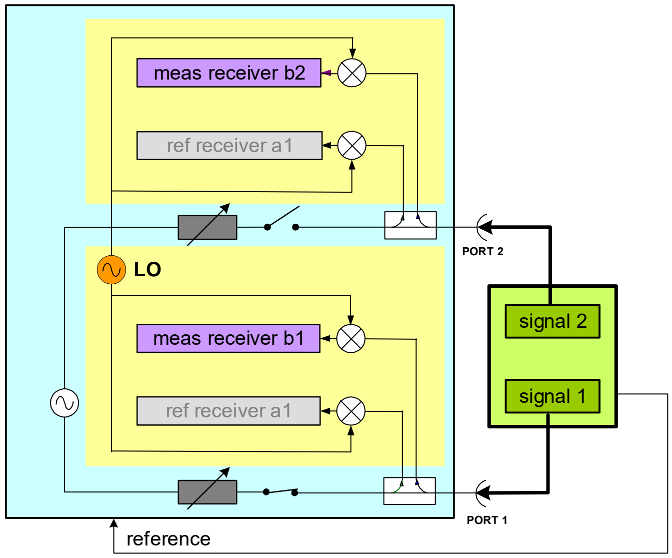


Fig. 2-3: Phase measurement between two signals

Measuring the ratio b2/b1 the relationship between the carriers according to magnitude and phase will be displayed. It is recommended to connect the reference frequencies between the DUT and the analyzer. Otherwise the measurement bandwidth has to be chosen so wide as to include the uncertainty of the frequencies. It does not matter if the frequencies slightly vary during the measurement. They only have to remain within the receiver window defined by the measurement bandwidth of the VNA. If the trace noise is too high, apply smoothing or averaging, or both. The reduction of the IF bandwidth might fail when the frequency of the DUT is not accurate enough and when no common reference is used. This measurement is normally done in CW mode at single frequencies.

3 The calibration

A phase measurement is influenced by the length of the cables used to connect the SUT (signal under test) to the analyzer. Therefore a calibration is required. A well matched symmetrical power splitter is recommended as a calibration standard. (For example, the power splitter ZFRSC-183 from Minicircuits has nearly negligible imbalance for magnitude and phase).

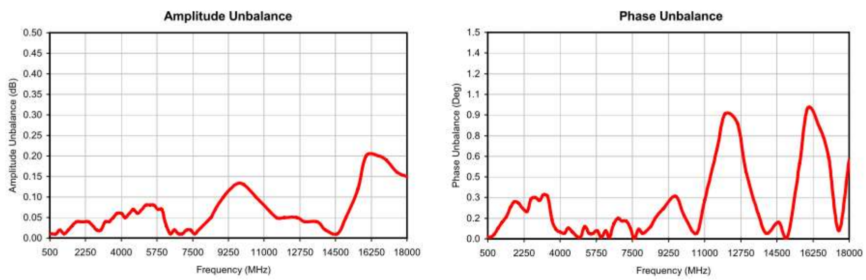


Fig. 3-1:Phase and amplitude imbalance of power splitter ZFRSC-183 from Minicircuits

For higher accuracy requirements, the imbalance can be measured with the network analyzer and corrected by applying a magnitude or phase offset.

An additional error is caused by the finite port matches of the DUT, the VNA and the power splitter used for calibration. To reduce this error, the test port match can be improved by adding well-matched attenuators (e.g. BW-S10W2 from Minicircuits) at the end of each cable. The phase error due to mismatch will be below 0,6°, assuming a port match of 25 dB at the end of the test cables respectively the attenuators, and a port match of 15 dB for the DUT.

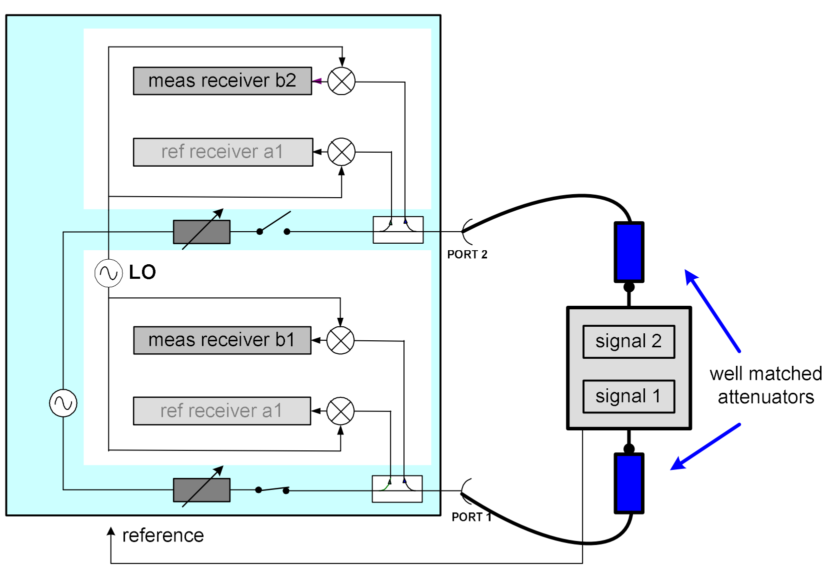


Fig. 3-2: Improvement of test port match with attenuators

For calibration the power splitter is connected to one port of the DUT while both other ports are connected to the test ports of the analyzer.

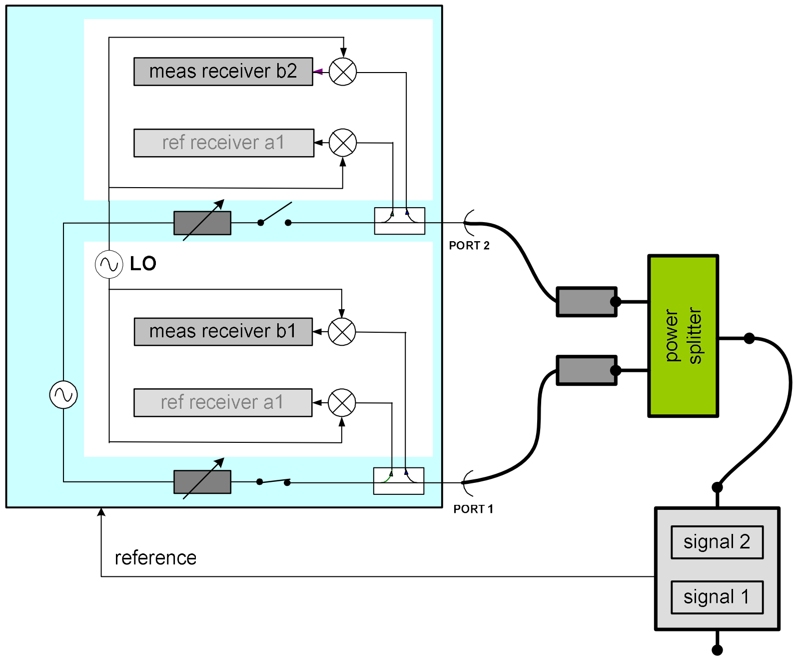
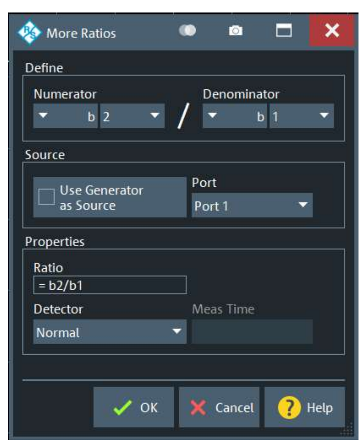


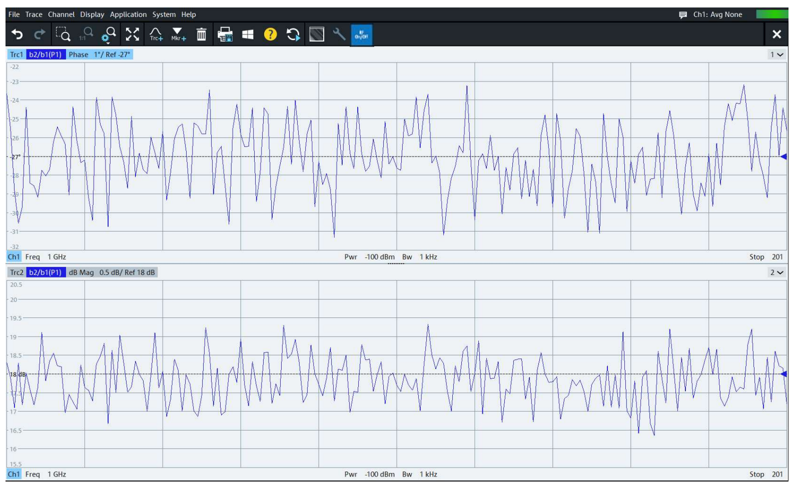
Fig. 3-3: Setup for calibration with a power splitter

Using trace mathematics, the imbalance of the test setup is corrected. Because the amplitude imbalance of the power splitter is negligible (<0,2 dB), the deviation of the magnitudes of both signals is measured with high accuracy as well.

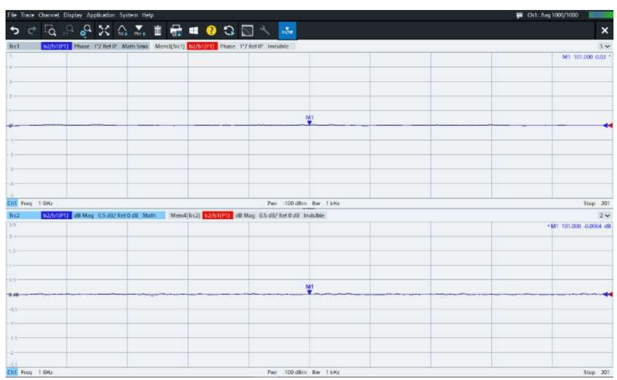
4 Measuring the phase between two signals

4.1 The settings for R&S®ZNA

Connect the cables to port 1 and port 2.	
If available connect the reference frequency to the R&S®ZNA, and set the R&S®ZNA to external reference frequency. Typically the BNC input is used. For high reference frequencies such as 100 MHz or 1 GHz please use the SMA input.	**System** - SETUP-FREQ.REF.-External (BNC)
Switch the R&S®ZNA to CW mode.	**Channel - Sweep -** SWEEP TYPE - CW Mode
Select the frequency to measure.	**Stimulus - Center -** STIMULUS - CW Frequency e.g. 1 GHz
Select a suitable measurement bandwidth that is as wide as the frequency uncertainty, e.g. 1 kHz.	**Channel - Pow BW Avg -** BANDWIDTH: 1 kHz
Select a suitable ratio, in this case b2/b1. Source Port 1 means that Port 1 drives during the measurement. The source power will be switched off later to avoid interferences with the measurement signal at port 1.	**Trace - Meas - DUT TYPE Non Frequency Converting-Ratio-**DUT TYPE NON FREQUENCY CONVERTING-MORE RATIOS - b2/b1 SRC Port1 

Select Phase format Add a second trace to display the magnitude. The ratio b2/b1 is set automatically, similar to the previous trace. If not, configure it accordingly to the previous trace. The magnitude is displayed by default.	**Trace - Format -** Phase **Trace - Trace Config -** ADD TRACE+DIAGRAM **Trace - Meas -** Ratio - b2/b1 SRC PORT1
Switch off the power of all sources to avoid interference	**Channel - Pow BW Avg -** POWER - RF Off All Channels
Add the maximum source step attenuation at port 1, e.g. 70 dB. Set the electronic power level to -100 dB or the minimum value	**Channel - Pow BW Avg -** Source Step Att. Source 1 - 70 dB POWER -100 dB
	

4.2 Calibration with R&S®ZNA

<table>
<tr><td>Connect the power splitter to one port of the DUT. Connect the test port cables with the attenuators directly to the power splitter. Use well matched power splitters at the end of the test port cables</td><td></td></tr>
<tr><td>Activate trace 1 by clicking into the trace 1 diagram, for example. Apply trace math</td><td>Trace - Trace Config - MEM MATH-
Data to New Mem
Activate DATA / MEMx(Trcy)
Deactivate SHOW MEMx(Trcy)</td></tr>
<tr><td>Activate trace 2 by clicking into the trace 2 diagram, for example. Apply trace math</td><td>Trace - Trace Config - MEM MATH-
Data to New Mem
Activate DATA / MEMx(Trcy)
Deactivate SHOW MEMx(Trcy)</td></tr>
<tr><td colspan="2">Both traces show 0° and 0 dB as the calibrated result
</td></tr>
</table>

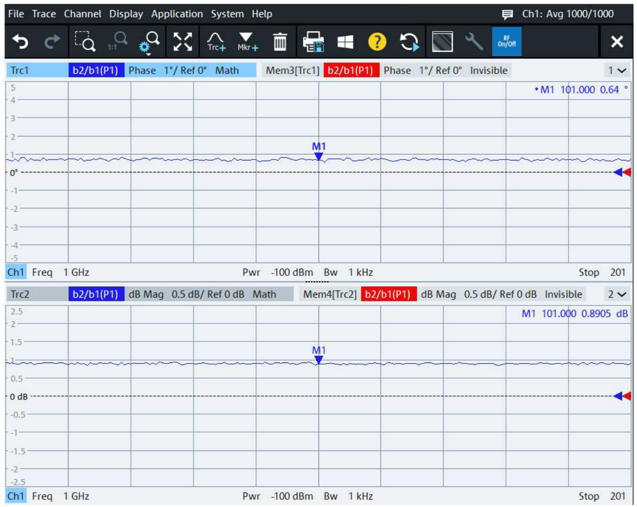


Fig. 4-1: Phase and magnitude between both signals after calibration measured with R&S®ZNA

More than 2 signals can also be measured by using the direct source and receiver access option R&S®ZNA-B16. All four or eight (in case of a four-port instrument) receivers can be used to compare up to four respectively eight signals. Calibration and measurement works in the same way as described above.

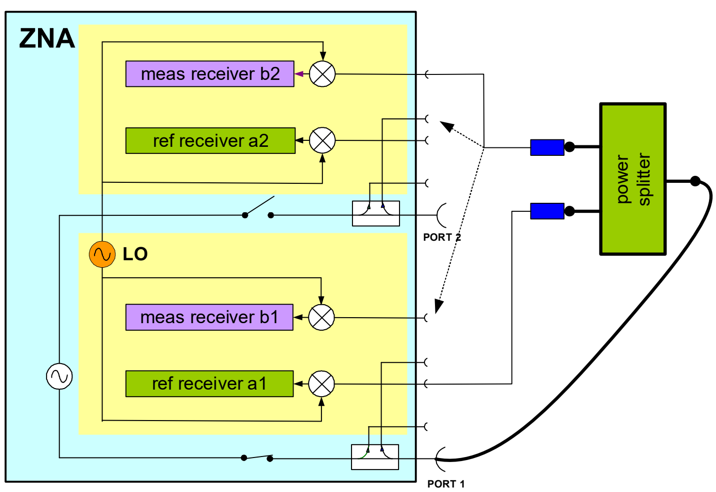


Fig. 4-3: Calibration of R&S®ZNA with direct source and receiver access option R&S®ZNA-B16

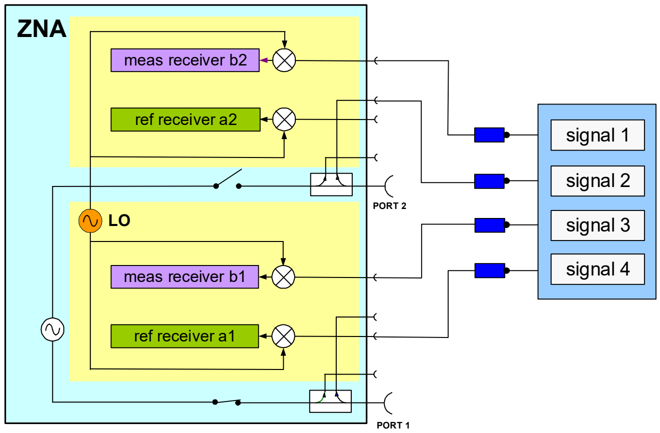
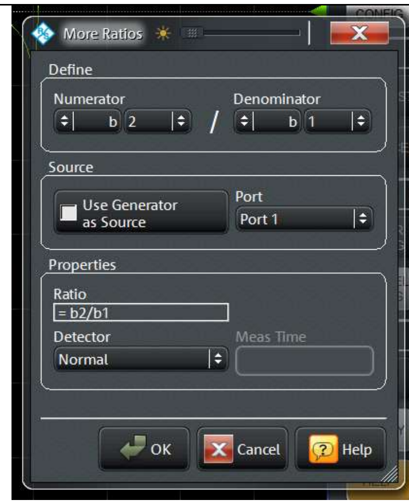


Fig. 4-4: Measurement with R&S®ZNA with direct source and receiver access option R&S®ZNA-B16

4.3 The settings for R&S®ZNB and R&S®ZNBT

Connect the cables to port 1 and port 2.	
If available, connect the reference frequencies together and switch R&S®ZNB to external reference frequency.	**System** - EXTERNAL REFERENCE
Switch the R&S®ZNB to CW Mode	**Channel - Sweep -** SWEEP TYPE - CW MODE
Select the frequency to be measured, e.g. 1 GHz	**Channel - Stimulus -** CW FREQUENCY : 1 GHz
Select a suitable measurement bandwidth that is as wide as the frequency uncertainty, e.g. 1 kHz	**Channel - Pow BW Avg -** BANDWIDTH: 1kHz
Select a suitable ratio, in this case b2/b1.	**Trace - Meas -** Ratio - MORE RATIOS:b2/b1

	 Push OK
Select phase format	**Trace - Format -** Phase
Switch off the power of the generator to avoid interferences	**Channel - Pow BW Avg -** POWER - RF OFF ALL CHANNELS:ON
If extended power range option is installed, reduce the power to a minimum.	**Channel - Pow BW Avg -** POWER: -85 dBm
Add a second trace to display the magnitude of the ratio	**Trace - Trace Config -** ADD Tr+Diag **Trace - Meas -** Ratio - MORE RATIOS:b2/b1 Push OK

4.4 Calibration with R&S®ZNB and R&S®ZNBT

Connect the power splitter to one port of the DUT. Connect the test port cables with the attenuators directly to the power splitter	
Activate trace 1 by clicking into the trace 1 diagram, for example. Apply trace math	**Trace - Trace Config - MEM MATH-** DATA TO NEW MEM TRACE MATH : ON *Activates MATH=DATA/MEM* SHOW MEM x[Trcy]: Off 
Activate trace 2 by clicking into the trace 2 diagram, for example. Apply trace math	**Trace - Trace Config - MEM MATH-** DATA TO NEW MEM TRACE MATH : ON *Activates MATH=DATA/MEM* SHOW MEM x[Trcy]: Off

Both traces show 0° and 0 dB as calibrated result.

After connecting both signals to the R&S®ZNB, the traces will show the phase and the magnitude relation between both signals

.

5 Measuring the phase tracking between multiple signals in receiver modules

A typical application for this kind of measurement is the tracking of magnitude and phase between several receiver blocks. In this case the module is stimulated by the VNA. The input RF-frequency is converted to an output IF frequency and the VNA has to measure the ratios between all the output IF-signals.

This can be measured with the R&S®ZNA, the R&S®ZNB or the R&S®ZNBT. If the analyzer has to stimulate the DUT, one port has to be used as source for the RF signal. Therefore a four port R&S®ZNB can test up to 3 signals, a R&S®ZNA (with four port and option ZNA-B16) up to 8 signals and R&S®ZNBT (with 24 ports) up to 23 signals. If an external generator is used (that can be controlled by frequency and power by the ZNB), 4 ports are available to measure 4 signals with R&S®ZNB respectively 24 ports are available with R&S®ZNBT to test 24 signals.

Frequency [GHz]	R&S®ZNB (4-port)	R&S®ZNBT (24 port)	R&S®ZNA (4-port) +ZNA-B16
8,5	3 (4)*	23 (24)*	8
20	3 (4)*	15 (16)*	-
26,5 / 43,5	3 (4)* (40 GHz)	-	8

*) external generator required

Table 5-1: Maximum number of signals that can be measured

A four-port R&S®ZNA with direct source and receiver access (Option R&S®ZNA-B16) includes eight receivers and two sources. Thus it can measure eight signals and stimulate the DUT. The sources provide the RF input signal as well as the LO signal, while the receivers operate at the IF frequency. This requires the scalar mixer and arbitrary frequency-converting measurements option R&S®ZNA-K4.

Because direct receiver input is selected, the power level should not exceed -15 dBm to avoid compression. For higher power levels, attenuators or the internal step attenuators have to be activated. External attenuators are in any case recommended to improve the test port match to get higher accuracy.

The R&S®ZNA can measure every ratio between every receiver. However it is sufficient to measure the ratio between all signals and one "reference signal". If the signals have different power levels, the strongest signal should be selected as "reference signal". In the following example, the reference signal is connected to the reference receiver of Port 1, the a1 receiver.

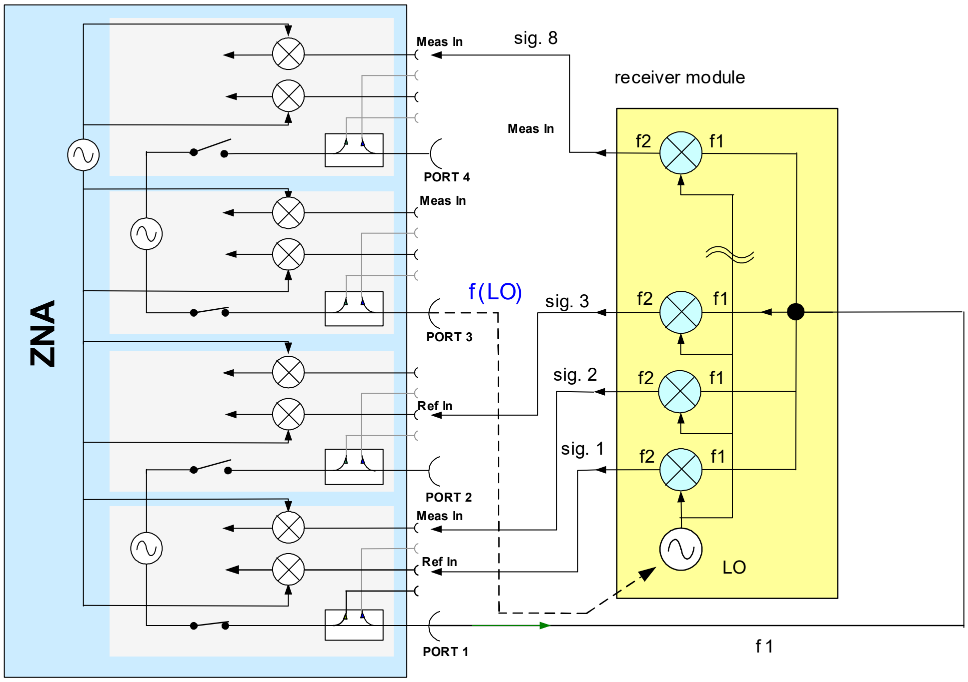
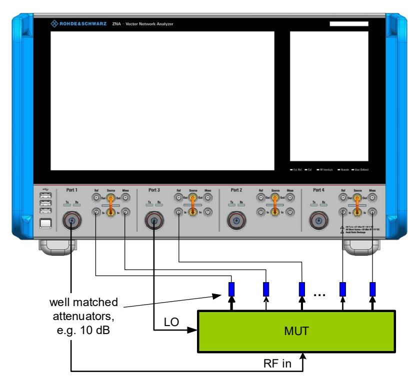
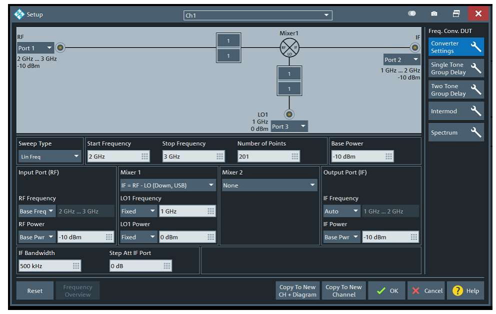
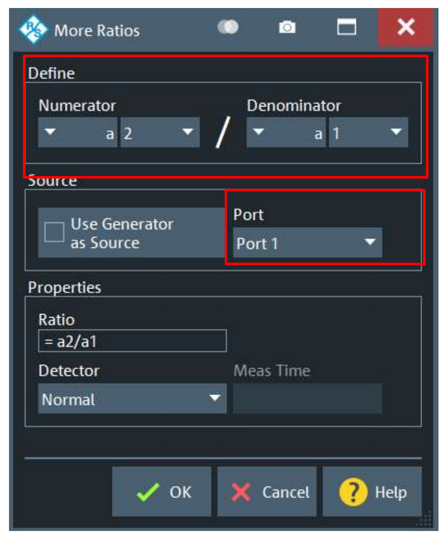


Fig. 5-1: Phase measurement between eight signals The DUT is stimulated by the R&S®ZNA

5.1 The settings for R&S®ZNA

Remove all R&S®ZNA-B16 loops from the reference and measurement receiver connectors. Leave the loops of the sources connected. Connect the RF input signal from test port 1 to the RF port of the DUT. Use the port 3 source as LO. Connect the output signals to the Ref In and Meas In of the R&S®ZNA. Use attenuators to improve test port match and to avoid receiver compression. Input the signal that should be the reference for the comparison to the other signals to Ref In of Port 1	
Configure the frequency converting measurement. For example: RF: 2 GHz..3 GHz LO: 1 GHz IF: 1 GHz…2 GHz	**Trace - Meas- DUT TYPE FREQUENCY CONVERTING-** CONVERTER GAIN-SETUP FREQUENCY CONVERTING DUT

Configure the trace. Select Port 1 as RF input, Port 2 as output and Port 3 as LO. Configure frequencies and power levels as specified above. Press OK	
Add the required traces	**Trace - Trace Config -** ADD TRACE+DIAG AREA *Apply "Add Trace + Diag Area" 7 times to generate 7 traces in 7 diagrams*
Activate every trace with the marker and select for every trace the corresponding ratios as b1/a1; a2/a1 ; b2/a1; a3/a1; b3/a1; a4/a1; b4/a1 The Source Port has to be Port 1	**Trace - Meas - Non Frequency Converting -** RATIOS - MORE RATIOS 
If required the magnitude can be measured as well. Switch the format to dB mag.	**Trace - FORMAT -** dB MAG

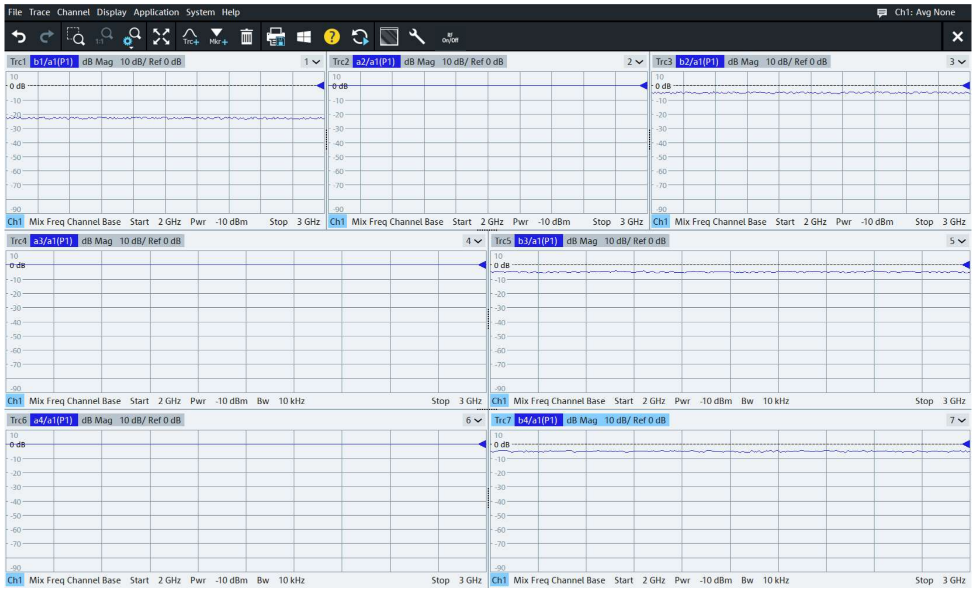


Fig. 5-2: The measurement of the phase relation between the signals

5.2 The calibration with R&S®ZNA

The calibration is also done with the power splitter. It can be applied to one of the outputs of the DUT to use this IF signal for calibration.

As alternative, the power splitter can be applied to the source at port 3, for example. In this case the frequency has to be changed, using the port configuration.

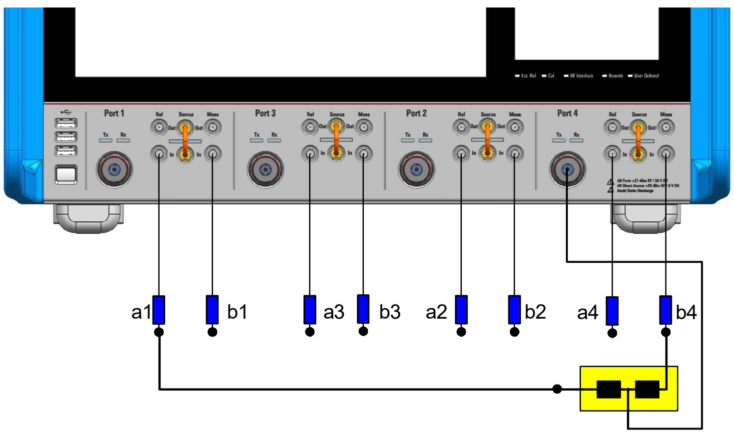
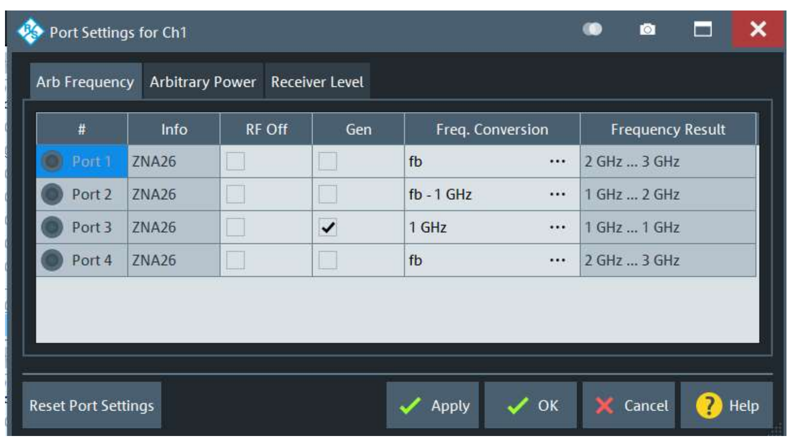
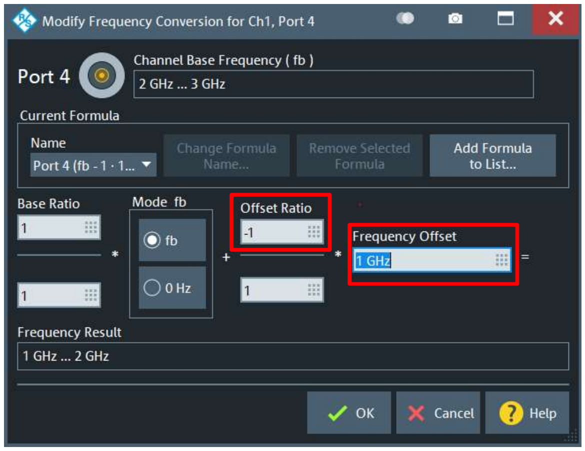


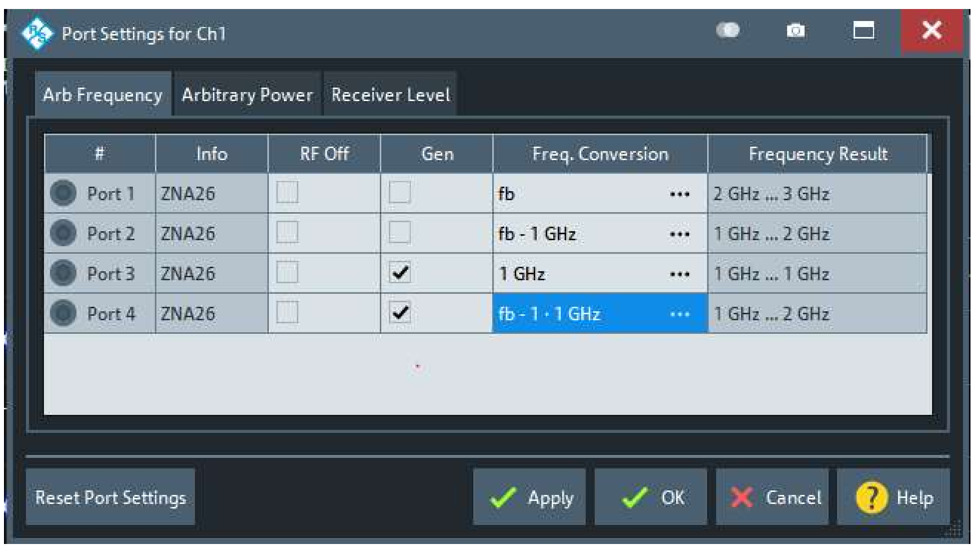
Fig. 5-3: Calibration with a power splitter

<table>
<tr><td>Open the port configuration</td><td>Channel - CHANNEL CONFIG - PORT CONFIG - PORT SETTINGS</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td colspan="2">Switch Port 4 permanently on by setting the check mark in the "Gen" column for Port 4. Change the frequency of Port 4 to the IF-frequency by clicking on the "…" button next to " fb".
Set the frequency by subtracting the LO frequency (LO frequency 1 GHz). Set the nominator to -1 to multiply (-1/1) with 1 GHz.</td></tr>
</table>



Press OK

The dialog should look as below. The power level is - 10 dBm by default. It can be changed if necessary by clicking on the "…" button next to Pb.



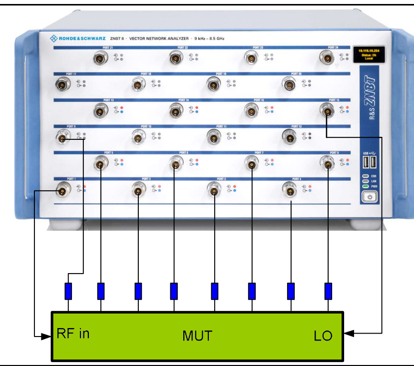
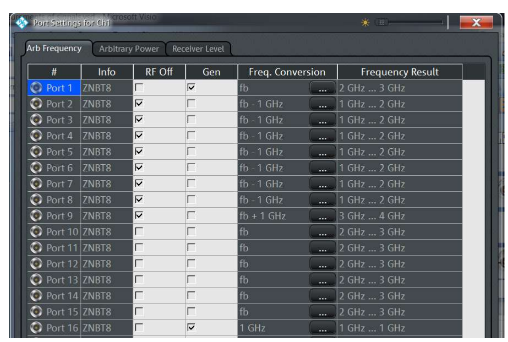
Push OK to leave the dialog and to apply the settings. Port 4 can be used for calibration now. Connect a port from the power splitter to the a1 receiver.

Connect the other port to the b1 receiver (Meas In of port 1)	
Select the trace b1/a1 e.g. by clicking into the diagram with the mouse and applying trace math	**Trace - Trace Config -** MEM MATH - DATA TO NEW MEM Activate TRACE MATH DATA/MEMx(Trcy) SHOW MEMx(Trcy) : Off

Perform the calibration for every ratio by connecting the power splitter to every receiver port	

5.3 The settings for R&S®ZNBT

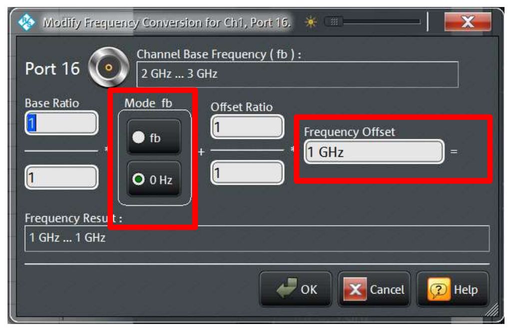
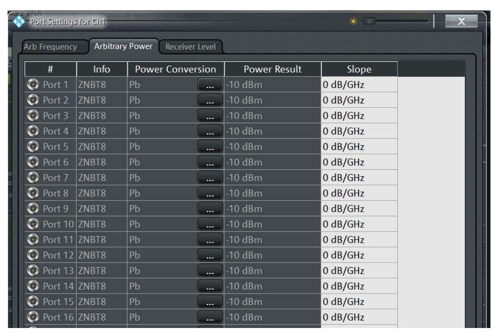
ZNBT with 12 ports or more is equipped with a second source. The first source can be routed from port 1 to port 8, the second source from port 9 to port 24. R&S®ZNBT with 24 ports can compare up to 22 signals when R&S®ZNBT sources provide the RF and the LO signals. For the example, port 1 is used as RF signal and port 16 as LO signal. For this measurement the frequency conversion option R&S®ZNBT-B4 is necessary.

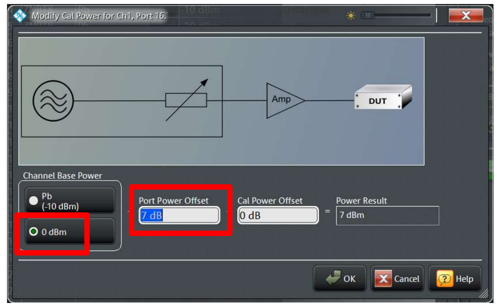
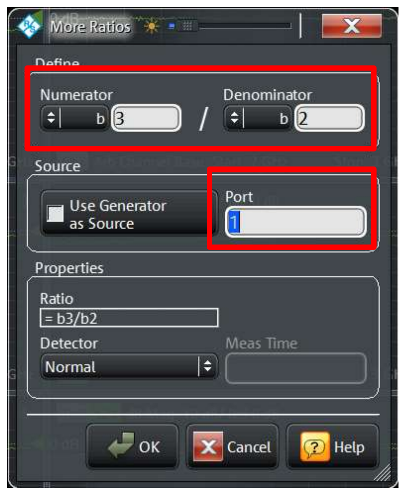
Connect the signals to compare to port 2, and port 9. Use port 1 as RF and port 16 as LO	
Configure the frequency converting measurement: RF: 2 GHz..3 GHz LO: 1 GHz IF: 1 GHz…2 GHz	**Channel - Stimulus - Start -** *2 GHz* **Channel - Stimulus - Stop -** *3 GHz* **Channel - Channel Config** - PORT CONFIG - PORT SETTINGS
Configure the dialog. Select port 1 as RF and Port 16 as LO, Switch RF Off for port 2 to port 9; Switch port 1 and port 16 to the "Gen" mode, so permanently on. The RF frequency is already set.	

<table>
<tr>
<td>Configure the frequencies for the IF Push the "…" button of port 2 in the Frequency Conversion column.

Subtract the LO frequency (here 1 GHz) to set the receiver frequency to the IF frequency. Push OK.

Perform this setting for port 3 to port 9 (all IF ports)</td>
<td>
</td>
</tr>
<tr>
<td>Configure the frequency for the LO
Push the "…" button of port 16 in the Frequency Conversion column.

Enter the frequency as 1 GHz; Set Mode fb to 0 Hz.
Push OK.</td>
<td>
</td>
</tr>
<tr>
<td>Set the power level for LO</td>
<td>Select the Arbitrary Power Tab

</td>
</tr>
</table>

Push the "…" button of port 16 Select Channel Base Power 0 dBm Enter as Port Power Offset the desired power for the LO, e.g. 7 dBm Push OK Leave the port settings dialog by clicking OK	
Add 6 traces in 6 diagrams (7 traces in total) and configure the necessary ratios b3/b2 , b4/b2; b5/b2; b6/b2; b7/b2 ; b8/b2; b9/b2 Activate the trace by clicking into the diagram, for example. Select the receivers as nominator and denominator and use port 1 as source. Leave the dialog by clicking OK	**Trace - Meas** - RATIO - MOERE RATIOS 
Select Phase as Format If required the magnitude can be measured as well. Switch the format to dB Mag. Additional traces can be generated as well, but this requires an additional calibration	**Trace - Format** - PHASE **Trace - Format -** dB MAG

5.4 The calibration with R&S®ZNBT

The calibration requires a power splitter. In the following section the frequency of the LO port 16 is switched to the IF frequency, to apply the power splitter to port 16 for calibration.

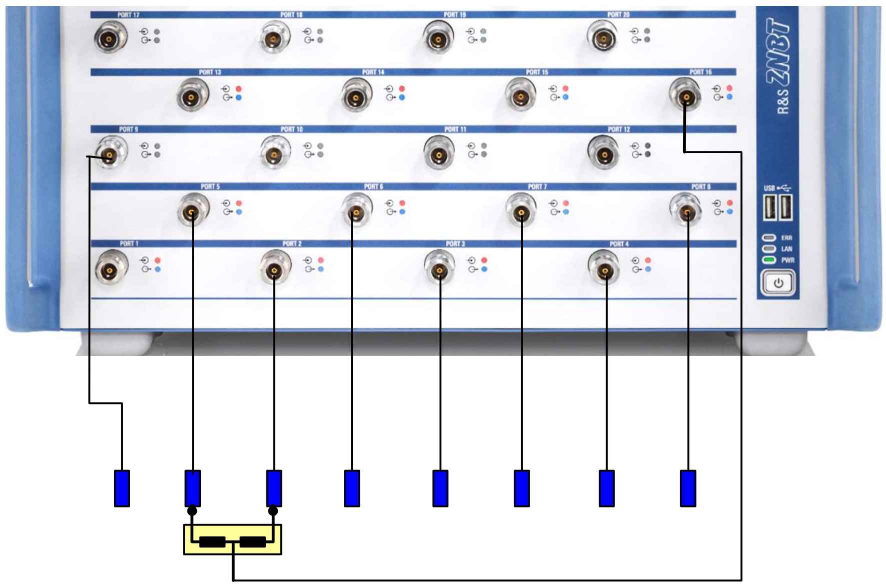
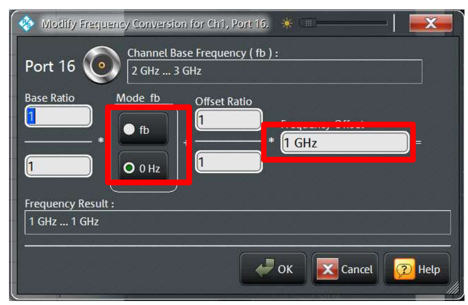


Fig. 5-4: Calibration with a power splitter

Switch the LO frequency to the IF frequency of the DUT	**Channel - Channel Config** - PORT CONFIG - PORT SETTINGS
Configure the frequency for the LO Push the "…" button of port 16 in the Frequency Conversion column. Enter the frequency of -1 GHz; Set "Mode fb" to fb. Push OK.	

Connect the power splitter with one port to port 2 of R&S®ZNBT. Connect the other port to the port to be calibrated, such as port 3 Activate the trace with the corresponding ratio, here trace 1 by clicking into the diagram and apply trace math Repeat this step for every ratio.	**Trace - Trace Config - MEM MATH -** DATA TO NEW MEM TRACE MATH : ON *Activates MATH=DATA/MEM* SHOW MEM x[Trcy]: Off	
When calibration is finished switch the frequency of port 16 back to the LO frequency; Push the "…" button of port 16 in the Frequency Conversion column. Enter the frequency of 1 GHz; Set Mode fb to 0 Hz. Push OK.		

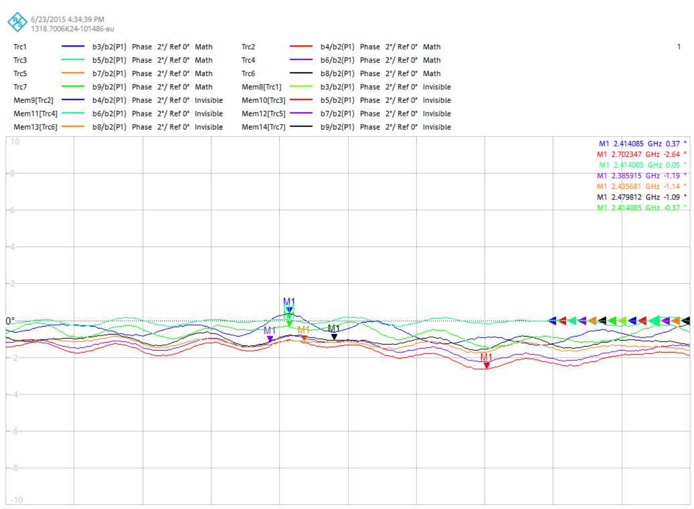


Fig. 5-5: Phase measurements with R&S®ZNBT

6 Conclusion

Using R&S®ZNA, R&S®ZNB or R&S®ZNBT, the phase relation between up to 24 signals can be measured easily and with high accuracy. If more signals must be measured R&S®ZNB or R&S®ZNBT can be used with switch matrixes. For example R&S®ZNB-Z84/85 can be used in combination with R&S®ZNBT for up to 255 signals, but this requires more effort for calibration.

7 Ordering Information

Designation	Type	Frequency range	Order No.
Vector network analyzer, 2 Ports, 26,5 GHz, 3.5 mm connectors	R&S®ZNA26	10 MHz to 26,5 GHz	1332.4500.22
Vector network analyzer, 4 Ports, 26,5 GHz, 3.5 mm connectors	R&S®ZNA26	10 MHz to 26,5 GHz	1332.4500.24
Vector network analyzer, 2 Ports, 43,5 GHz, 2.92 mm connectors	R&S®ZNA43	10 MHz to 43,5 GHz	1332.4500.42
Vector network analyzer, 4 Ports, 43,5 GHz, 2.92 mm connectors	R&S®ZNA43	10 MHz to 43,5 GHz	1332.4500.44
Vector network analyzer, 2 Ports, 43,5 GHz, 2.4 mm connectors	R&S®ZNA43	10 MHz bis 43,5 GHz	1332.4500.43
Vector network analyzer, 4 Ports, 43,5 GHz, 2.4 mm connectors	R&S®ZNA43	10 MHz bis 43,5 GHz	1332.4500.45
Direct source and receiver access	R&S®ZNAx-B16	as instrument	1332.4581.xx
Source step attenuator for R&S®ZNA26/43	R&S®ZNAx-B21/B22/B23/B24	as instrument	1332.4630/46.xx
Receiver step attenuator for R&S®ZNA26/43	R&S®ZNAx-B31/32/33/34	as instrument	1332.4700/17.xx
Mixer measurements and arbitrary frequency-converting measurements	R&S®ZNA-K4	as instrument	1332.5342.02

Designation	Type	Frequency range	Order No.
Vector Network Analyzer, 8 ports, 20 GHz, 3.5 mm	R&S®ZNBT20	100 kHz to 20 GHz	1332.9002.24
Vector Network Analyzer, 8 ports, 26.5 GHz, 2.92 mm	R&S®ZNBT26	100 kHz to 26.5 GHz	1332.9002.34
Vector Network Analyzer, 8 ports, 40 GHz, 2.92 mm	R&S®ZNBT40	100 kHz to 40 GHz	1332.9002.44
Adds Ports 5 to 8, for R&S®ZNBT8	R&S®ZNBT8-B108	9 kHz to 8.5 GHz	1319.4200.02
Adds Ports 9 to 12, for R&S®ZNBT8	R&S®ZNBT8-B112	10 kHz to 8.5 GHz	1319.4217.02
Adds Ports 13 to 16, for R&S®ZNBT8	R&S®ZNBT8-B116	11 kHz to 8.5 GHz	1319.4223.02
Adds Ports 17 to 20, for R&S®ZNBT8	R&S®ZNBT8-B120	12 kHz to 8.5 GHz	1319.4230.02
Adds Ports 21 to 24, for R&S®ZNBT8	R&S®ZNBT8-B124	13 kHz to 8.5 GHz	1319.4246.02
Adds Ports 9 to 12, for R&S®ZNBT20	R&S®ZNBT20-B112	100 kHz to 20 GHz	1332.9454.02
Adds Ports 13 to 16, for R&S®ZNBT20	R&S®ZNBT20-B116	100 kHz to 20 GHz	1332.9460.02
Adds Ports 17 to 20, for R&S®ZNBT20	R&S®ZNBT20-B120	100 kHz to 20 GHz	1332.9302.02
Adds Ports 21 to 24, for R&S®ZNBT20	R&S®ZNBT20-B124	100 kHz to 20 GHz	1332.9319.02
Adds Ports 9 to 12, for R&S®ZNBT26	R&S®ZNBT26-B112	100 kHz to 26.5 GHz	1332.9454.34
Adds Ports 13 to 16, for R&S®ZNBT26	R&S®ZNBT26-B116	100 kHz to 26.5 GHz	1332.9460.34
Adds Ports 17 to 20, for R&S®ZNBT26	R&S®ZNBT26B120	100 kHz to 26.5 GHz	1332.9302.34
Adds Ports 21 to 24, for R&S®ZNBT26	R&S®ZNBT26-B124	100 kHz to 26.5 GHz	1332.9319.34
Adds Ports 9 to 12, for R&S®ZNBT40	R&S®ZNBT40-B112	100 kHz to 40 GHz	1332.9454.44
Adds Ports 13 to 16, for R&S®ZNBT40	R&S®ZNBT40-B116	100 kHz to 40 GHz	1332.9460.44
Adds Ports 17 to 20, for R&S®ZNBT40	R&S®ZNBT40-B120	100 kHz to 40 GHz	1332.9302.44
Adds Ports 21 to 24, for R&S®ZNBT40	R&S®ZNBT40B124	100 kHz to 40 GHz	1332.9319.44
Frequency Conversion	R&S®ZNBT-K4	as instrument	1318.8431.02

About Rohde & Schwarz

The Rohde & Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcasting, secure communications, and radiomonitoring and radiolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries. The company is headquartered in Munich, Germany.

Regional contact

Europe, Africa, Middle East
+49 89 4129 12345
customersupport@rohde-schwarz.com

North America
1 888 TEST RSA (1 888 837 87 72)
customer.support@rsa.rohde-schwarz.com

Latin America
+1 410 910 79 88
customersupport.la@rohde-schwarz.com

Asia Pacific
+65 65 13 04 88
customersupport.asia@rohde-schwarz.com

China
+86 800 810 82 28 |+86 400 650 58 96
customersupport.china@rohde-schwarz.com

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management ISO 9001

Certified Environmental Management ISO 14001

PAD-T-M: 3573.7380.02/02.02/EN/

Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15 | D - 81671 München
Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com