



Products: R&S® Network Analyzer ZVL, ZVA, ZVB, ZVT

Balanced Reflection Measurement with R&S® ZVL

Application Note

This application note describes how to measure balanced reflection mixed mode S-Parameters with a 2-port Network Analyzer like R&S® ZVL. The application note directly transfers S-Parameter Trace Data from R&S® Network Analyzers to Microsoft™ Excel™ using a direct connection like GPIB or LAN and does the mode conversion to Mixed Mode inside Excel™ with a VBA Macro.



Contents

1. Overview	3
2. Preparation.....	3
2.1. GPIB for Control PC	4
2.2. Preparations for LAN: RSIB32.dll	4
2.3. LAN/Ethernet	5
2.3.1. ZVL	6
2.3.2. ZVA, ZVB, ZVT	7
2.4. LAN/Ethernet using direct Crossover connection between PC and Network Analyzer	8
3. Operation of the ZVx_Balanced.xls Tool.....	8
3.1. Screen of ZVx_Balanced-Tool.....	9
3.1.1. Resource String of instrument.....	9
3.1.2. Instrument Identification	10
3.1.3. Instrument Execution Button for download of trace data	10
3.1.4. Frequency List	11
3.1.5. Magnitude (dB) and Phase parameter of Mixed Mode S- Parameter Trace Data	11
3.2. Graphical Result View in Excel™	11
3.2.1. Example: View for Sdd11	12
4. Hardware and Software Requirements	13
4.1. PC Hardware Requirements.....	13
4.2. PC Software Requirements	13
5. Literature	13
6. Additional Information	13
7. Ordering information	14

1. Overview

This application note describes how to measure balanced reflection mixed mode S-Parameters with a 2-port Network Analyzer like ZVL. The application note directly transfers S-Parameter Trace Data from R&S® Network Analyzers to Microsoft™ Excel™ using a direct connection like GPIB or LAN and does the mode conversion to Mixed Mode inside Excel™ with a VBA Macro.

Prerequisites are a PC running Microsoft Excel™, a R&S® Network analyzer like ZVL, ZVA, ZVB or ZVT as well as a working remote control connection between PC and instrument like GPIB or LAN/Ethernet. .

The following abbreviations are used in the text for R&S® test equipment:

ZVA	R&S® ZVA Vector Network Analyzer
ZVB	R&S® ZVB Vector Network Analyzer
ZVL	R&S® ZVL Vector Network Analyzer
ZVT	R&S® ZVT Vector Network Analyzer
R&S	Rohde & Schwarz GmbH und Co. KG

2. Preparation

In order to use this application note, you need a remote control connection between the PC operating MS Excel™ and the R&S® Network Analyzer. There are following possibilities for this connection:

1. GPIB



2. LAN/Ethernet using Intranet or Internet



Preparation

- LAN/Ethernet using direct LAN or Crosslink LAN connection between PC and Network Analyzer



2.1. GPIB for Control PC

In order to use the GPIB interface, your PC must be equipped with a GPIB interface hardware.

In addition, the remote control library "VISA" needs to be installed on the PC. The VISA library is available e.g. at www.nationalinstruments.com

2.2. Preparations for LAN: RSIB32.dll

This Application Note shows how to use remote control of Rohde & Schwarz Network Analyzers over a local area network. Rohde & Schwarz VXIpn instrument drivers are based on VISA. Instrument Drivers as well as this Trace-To-Excel application can control the instrument via LAN if the RSIB interface and passport are installed.

The RSIB interface is a R&S® defined protocol that uses the TCPIP protocol for communication with the instrument. It consists of a set of I/O functions very similar to the National Instruments NI-488.2 interface for GPIB.

The following table shows some corresponding functions:

NI-488.2 functions	RSIB functions
ibfind	RSDLLibfind
ibwrt	RSDLLibwrt
ibrd	RSDLLibrd

A more detailed explanation of RSIB can be found in the Rohde&Schwarz application note 1EF47, "Remote Control of R&S® Spectrum and Network Analyzers via LAN". This application note is available at www.rohde-schwarz.com/appnote/1EF47.html. The application note comes together with the RSIB Passport as well as the necessary RSIB.dll library.

Please install the RSIB Passport according to application note 1EF47. Make sure the RSIB32.dll library is available in the Windows System folder of your remote control PC.

Preparation



2.3. LAN/Ethernet

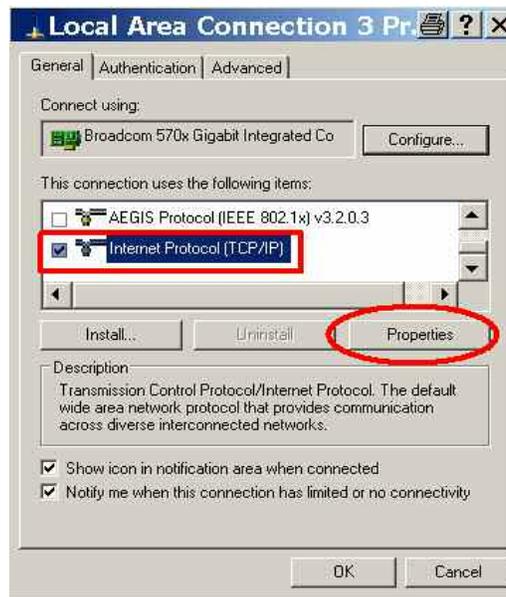
Both, PC and Instrument must be connected to the Local Area Network LAN and have a valid IP address inside the LAN. You can check the IP address of your PC from the Windows Control Panel inside the Network Connections.

For the R&S Network Analyzer instrument, please check first if the automatic assignment of an IP address (DHCP) is activated.

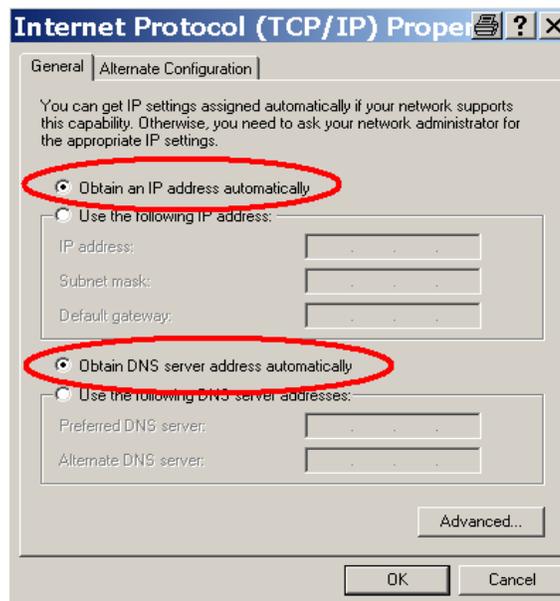
- In case of ZVA, ZVB or ZVT, Press the “Windows” button on the ZVx frontpanel in order to display the Windows Taskbar



- In case of ZVL, access Windows XP using an external keyboard
- Open Start->Settings->Network Connections->Local Area Network Connection
- In the dialog, select “Internet Protocol (TCP/IP) and go to “Properties”



- Make sure that the settings are “Obtain IP address automatically” and “Obtain DNS address automatically”



After confirmation of the automatic network settings, please check the obtained Network Analyzer IP address. You can do this in the following way:

2.3.1. ZVL

To check the IP address, proceed as follows:

1. Press hardkey “Setup”
2. Press softkey “General Setup”
3. Press softkey “IP Address” to display the ZVL IP address

2.3.2. ZVA, ZVB, ZVT

- Press Info Button



- Press the softkey "Hardware Info"



- Now you can find the IP address of the analyzer below the "IP addresses" section

Hardware Configuration

Instrument Type: ZVA24 with 4 Ports
Part Number: 1145.1110k26
Serial Number: 100171
Product Index: 01.00
IEC Bus Address: 20
IP Addresses
IP Address: 0.0.0.0 Subnet Mask: 0.0.0.0
IP Address: 10.7.11.54 Subnet Mask: 255.255.0.0
IP Address: 127.0.0.1 (Localhost) Subnet Mask: 255.0.0.0
SyMapping: ZVA_P4
LO Divider: is not active
Firmware Version: 2.01
Image:
Version 02.10

Please note that the ZVA, ZVB or ZVT instrument has two LAN ports. Depending on the port you are using, please use the first or second IP address in the Hardware info field.

- Final preparation step: Make sure that you have the LAN remote control library RSIB32.dll installed on your PC remote computer (see section 2.2).

2.4. LAN/Ethernet using direct Crossover connection between PC and Network Analyzer

You can also directly connect your remote PC to the ZVx Network Analyzer instrument by means of a normal LAN cable or by a crossover LAN cable.

A crossover LAN cable has same connector types as a normal LAN cable, however the wires inside the crossover cable are crossed.

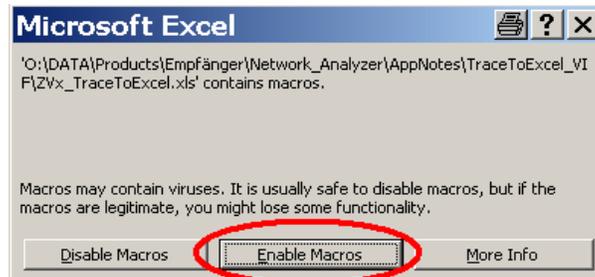
3. Operation of the ZVx_Balanced.xls Tool

This application note comes with an Excel™ file tool which enables you to directly transfer S-parameter trace data from Instrument to Excel™ and which does the mode conversion to Mixed Mode S-Parameters.

The mode conversion algorithm is documented in literature, see. e.g. [2] for the theoretical background and an algorithm explanation.

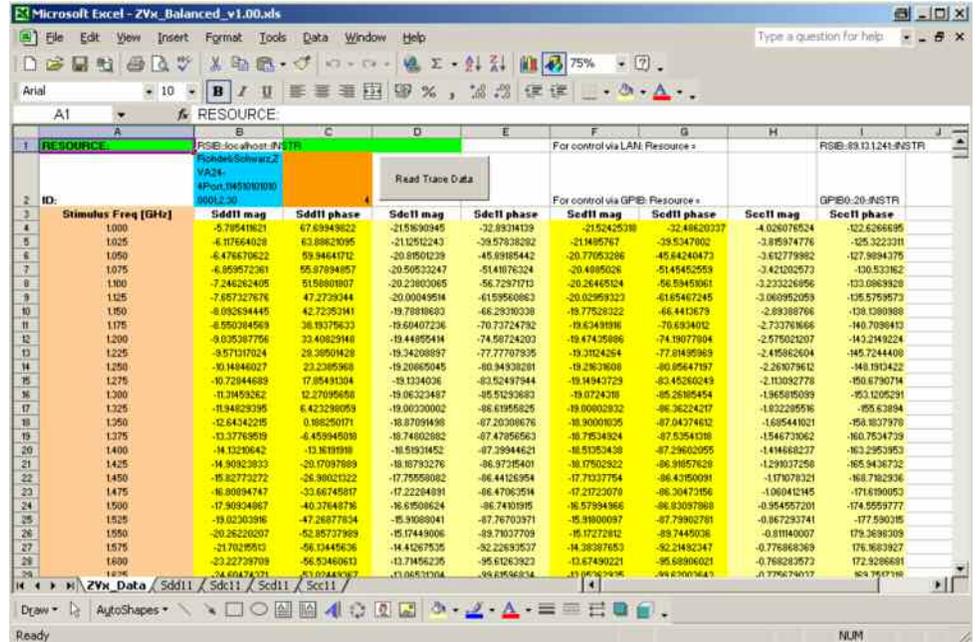
The supplied Excel-file ZVx_Balanced.xls consists of a spreadsheet and a software macro function written in Visual Basic for Applications VBA.

When opening the file ZVx_Balanced.xls, you will be asked to enable the macros. Attention: It is absolutely necessary to press "Enable Macro" here. The tool will not work without the macros.



3.1. Screen of ZVx_Balanced-Tool

After opening the Excel™ tool, you will find see a spreadsheet as shown below:



The spreadsheet consists of following elements:

- Resource String
- Instrument Identification
- Execution Button for download of trace data
- Frequency List
- Magnitude and Phase of Mixed Mode S-Parameter Trace Data (Sdd11, Sdc11, Scc11)

3.1.1. Resource String of instrument

This string is located in cell “B1” of the Excel™ spreadsheet (green color). Depending on the interface type, a different resource string is used to address the instrument.

GPIB Interface:

Use Resource String **“GPIB0::20::INSTR”**, where “GPIB0” = Name of GPIB interface and “20” = GPIB address of Network Analyzer

LAN Interface:

Use Resource String **“RSIB::89.13.1.241::INSTR”**, where “RSIB” = Name of interface, don’t change, and “89.13.1.241” = actual IP address of your network Analyzer

	A	B	C	D	E	
1	RESOURCE:	GPIB0::20::INSTR				For contr
		Rohde&Schwarz, ZVA24- 4Port,1145101010		Read Trace Data		
2	ID:	100001,2.30	4			For contr
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase	Sdc11 mag	Sdc11 phase	Scd11
4	1.000	-5.785411621	67.69949822	-21.51690945	-32.89314139	-21.1
5	1.025	-6.117664028	63.88621095	-21.12512243	-39.57838282	-21.14
6	1.050	-6.476670622	59.94641712	-20.81501239	-45.89185442	-20.77

3.1.2. Instrument Identification

This string is located in cell “B2” of the Excel™ spreadsheet (light blue color). The instrument identification string shows instrument type, model, serial number as well as FW version. The string is updated after each trace download from the instrument.

	A	B	C	D	E	
1	RESOURCE:	GPIB0::20::INSTR				For contr
		Rohde&Schwarz, ZVA24- 4Port,1145101010		Read Trace Data		
2	ID:	100001,2.30	4			For contr
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase	Sdc11 mag	Sdc11	
4	1.000	-5.785411621	67.69949822	-21.51690945	-32.89	
5	1.025	-6.117664028	63.88621095	-21.12512243	-39.57	
6	1.050	-6.476670622	59.94641712	-20.81501239	-45.89	

In the neighboring cell “C2”, you can find the detected number of ports (orange color).

In case of any problem with the instrument connection, there will be the message “Instrument not found” in this cell.

The string corresponds to the return value of the “*IDN?” remote control command.

3.1.3. Instrument Execution Button for download of trace data

With this button you can execute the download of the trace data from the instrument and start the conversion calculation to Mixed Mode S-Parameters.

	A	B	C	D	E	
1	RESOURCE:	GPIB0::20::INSTR				For con
		Rohde&Schwarz, ZVA24- 4Port,1145101010		Read Trace Data		
2	ID:	100001,2.30	4			For con
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase	Sdc11 mag	Sdc11 phase	Scd11
4	1.000	-5.785411621	67.69949822	-21.51690945	-32.89314139	-21.1
5	1.025	-6.117664028	63.88621095	-21.12512243	-39.57838282	-21.1
6	1.050	-6.476670622	59.94641712	-20.81501239	-45.89185442	-20.77

After pressing the “Download” button, the VBA Macro downloads all 4 S-Parameters of the currently active ZVx channel. Subsequently, the S-Matrix is converted to Mixed Mode S-Parameters. The results (Sdd11, Sdc11, Scd11, Scc11) will be shown in the spreadsheet by magnitude and phase each.

If the current instrument setup contains several channels, the Excel™ Macro will use the currently active channel settings for the trace download.

3.1.4. Frequency List

After the successful download of the trace data, you will find the corresponding frequency list in column A (pink color).

	A	B	C
1	RESOURCE:	GPIB0:20:INSTR	
		Rohde&Schwarz, ZVA24- 4Port,1145101010 100001,2,30	
2	ID:		4
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase
4	1.000	-5.785411621	67.69949822
5	1.025	-6.117664028	63.88621095
6	1.050	-6.478670622	59.94641712
7	1.075	-6.859572361	55.87894857
8	1.100	-7.246262405	51.58801807
9	1.125	-7.657327676	47.2739344
10	1.150	-8.092694445	42.72353141
11	1.175	-8.550384569	38.19375633
12	1.200	-9.035387756	33.40829148
13	1.225	-9.571317024	28.38501428

3.1.5. Magnitude (dB) and Phase parameter of Mixed Mode S-Parameter Trace Data

The Mag(dB) and phase values of the mixed mode S-Parameters of S11 can be found in columns B to I (yellow color).

This data is actually not directly downloaded from the instrument, but it is calculated within Excel™ VBA from the normal (single-ended) S-Parameters.

	A	B	C	D	E	F	G	H	I
1	RESOURCE:	GPIB0:20:INSTR				For control via LAN: Resource =			RSIB:89.13.1241:INS
		Rohde&Schwarz, ZVA24- 4Port,1145101010 10001,2,30		Read Trace Data					
2	ID:					For control via GPIB: Resource =			GPIB0:20:INSTR
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase	Sdcl1 mag	Sdcl1 phase	Sccl1 mag	Sccl1 phase	Scc11 mag	Scc11 phase
4	1.000	-5.785411621	67.69949822	-21.51630945	-32.89374139	-21.52425338	-32.48620337	-4.026076524	-122.6266895
5	1.025	-6.117664028	63.88621095	-21.1251244	-34.87826282	-21.1465747	-34.9417802	-3.88914335	-125.3223311
6	1.050	-6.478670622	59.94641712	-20.8050239	-35.83976442	-20.8278982	-35.8424073	-3.652779882	-127.3643375
7	1.075	-6.859572361	55.87894857	-20.52482639	-36.78187634	-20.5489584	-36.7849584	-3.428862573	-130.53178
8	1.100	-7.246262405	51.58801807	-20.23803065	-36.72971703	-20.26465124	-36.72971703	-3.228862573	-133.0869983
9	1.125	-7.657327676	47.2739344	-20.00049514	-36.5956086	-20.02983223	-36.5956086	-3.060952059	-135.5769577
10	1.150	-8.092694445	42.72353141	-19.78818683	-36.2930776	-19.77528322	-36.441719	-2.89388766	-138.1380766
11	1.175	-8.550384569	38.19375633	-19.61942236	-36.00724792	-19.6299988	-36.00724792	-2.746763558	-140.7198413
12	1.200	-9.035387756	33.40829148	-19.44098414	-35.69724302	-19.47436086	-35.69724302	-2.617607167	-143.3469714

3.2. Graphical Result View in Excel™

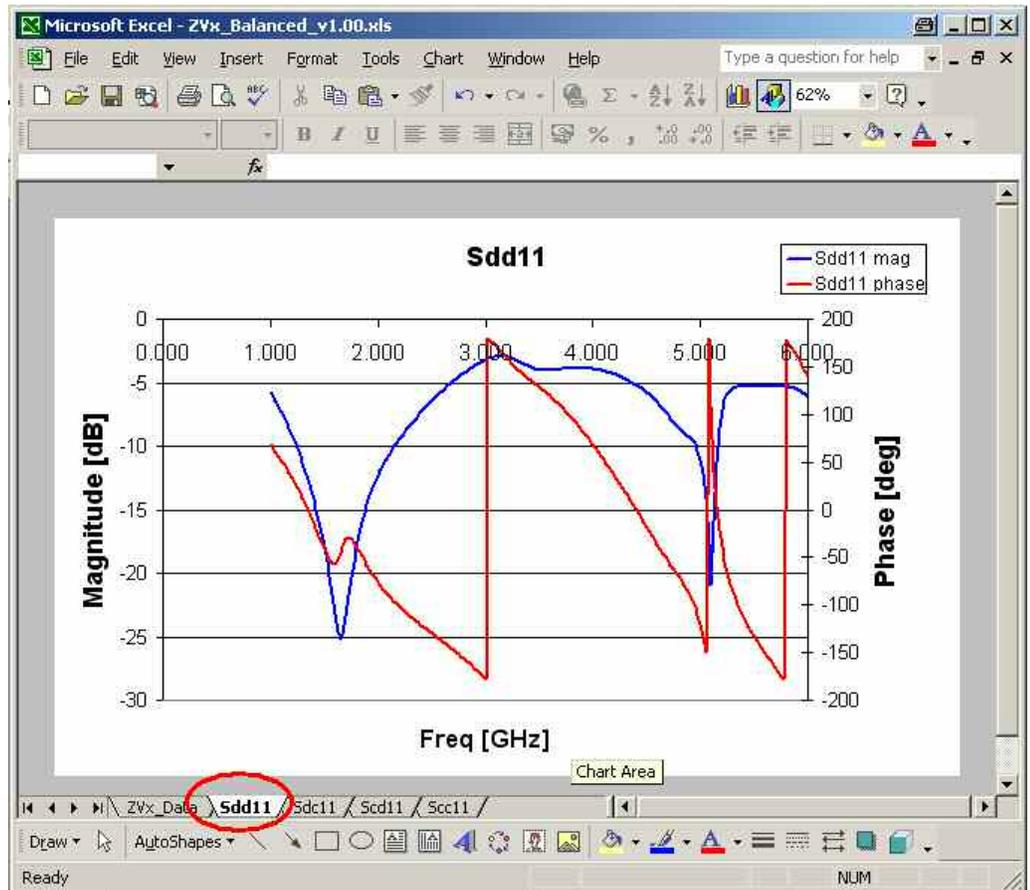
With the graphical functions inside MS Excel™, it is possible to display the downloaded trace data as a diagram.

An example is shown in ZVx_Balanced.xls in the four diagram pages “Sdd11”, “Sdc11”, “Scd11”, “Sccl1”.

Operation of the ZVx_Balanced.xls Tool

	A	B	C	D	E
1	RESOURCE:	GPIB0::20::INSTR			
		Rohde&Schwarz,Z		Read Trace Data	
		VA24-			
2	ID:	4Port,1145101010			
		0001,2,30		4	
3	Stimulus Freq [GHz]	Sdd11 mag	Sdd11 phase	Sdc11 mag	Sdc11 phase
4	1.000	-5.785411621	67.69949822	-21.51690945	-32.89314139
5	1.025	-6.117664028	63.88621095	-21.12512243	-39.57838282
6	1.050	-6.476670622	59.94641712	-20.81501239	-45.89185442
7	1.075	-6.859572361	55.87894857	-20.50533247	-51.41876324
8	1.100	-7.246262405	51.58801807	-20.23803065	-56.72971713
9	1.125	-7.657327676	47.2729344	-20.00049514	-61.59560863

3.2.1. Example: View for Sdd11



The display shows two traces: One for magnitude (blue), the other for phase (red). The corresponding Y-axes can be found on the left side (magnitude) and right side (phase).

4. Hardware and Software Requirements

4.1. PC Hardware Requirements

	Minimum	Recommended
CPU	Pentium 133 MHz	Pentium II 450 MHz or higher
RAM	32 Mbyte	128 MByte
Harddisc	10 MByte free space	50 MByte free harddisc space
Monitor	VGA monitor (640x480)	SVGA color monitor, resolution 800x600 or better
IEEE Bus or LAN/Ethernet	required	

4.2. PC Software Requirements

	Minimum	Recommended
OS	Windows 95 / 98 / NT 4.0 / 2000 / Me / XP	Windows 98 / 2000 / Me / XP
OS add-ons	---	Microsoft Internet Explorer 5.0 or above Microsoft Excel™2002 or above
IEEE Bus Driver	Version 1.70 (or above)	Version 1.70 (or above)
VISA	VISA 4.0	VISA 4.0
RSIB	RSIB 1.0	RSIB 1.0

5. Literature

[1] R&S Application note 1EF47, "Remote Control of R&S Spectrum and Network Analyzers via LAN", available at www.rohde-schwarz.com

[2] D. E. Bockelman, W. R. Eisenstadt, "Combined Differential and Common-Mode Scatterin Parameters: Theory and Simulation", IEEE Trans. on MTT, Vol. 43, No. 7, July 1995, pp. 1530-1539

6. Additional Information

This application note and the associated program are updated from time to time. Please visit the website www.rohde-schwarz.com/appnote in order to download new versions. Please send any comments or suggestions about this application note to TM-Applications@rsd.rohde-schwarz.com.

7. Ordering information

2-port Network Analyzers

R&S® ZVL3	9 kHz to 3 GHz	1303.6509.03 (2 ports)
R&S® ZVL6	9 kHz to 6 GHz	1303.6509.06 (2 ports)
R&S® ZVA8	300 kHz to 8 GHz	1145.1110.08 (2 ports)
R&S® ZVA24	10 MHz to 24 GHz	1145.1110.24 (2 ports)
R&S® ZVA40	10 MHz to 40 GHz	1145.1110.40 (2 ports)
R&S® ZVA50	10 MHz to 40 GHz	1145.1110.50 (2 ports)
R&S® ZVB4	300 kHz to 4 GHz	1145.1010.04 (2 ports)
R&S® ZVB8	300 kHz to 8 GHz	1145.1010.08 (2 ports)
R&S® ZVB14	10MHz to 14 GHz	1145.1010.14 (2 ports)
R&S® ZVB20	10 MHz to 20 GHz	1145.1010.20 (2 ports)
R&S® ZVT8	300 kHz to 8 GHz	1300.0000.08 (2 ports to 8 ports)

Apart from the 2-port Network analyzers listed above, also multiport Network analyzer with 3, 4 ports (ZVB, ZVA) as well as 8-ports (ZVT) are available from Rohde & Schwarz.

Please note, that complete solutions for signal generation and signal analysis for various applications are available from Rohde & Schwarz.

For additional information about equipment, see the Rohde & Schwarz website www.rohde-schwarz.com.



ROHDE & SCHWARZ GmbH & Co. KG · Mühlhofstraße 15 · D-81671 München · Postfach 80 14 69 · D-81614 München ·
Tel (089) 4129 -0 · Fax (089) 4129 - 13777 · Internet: <http://www.rohde-schwarz.com>

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.