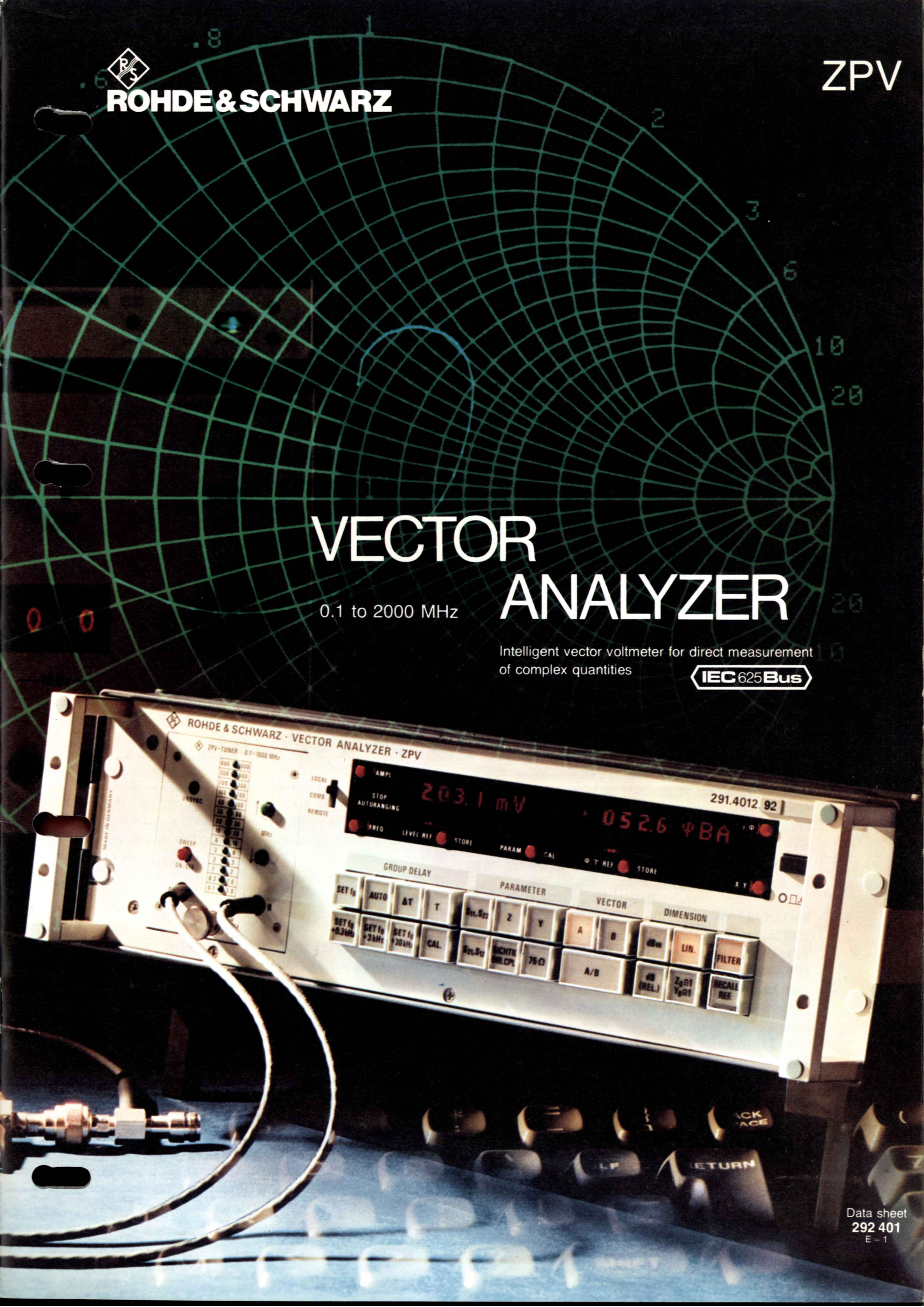
ROHDE & SCHWARZ

ZPV



VECTOR ANALYZER

0.1 to 2000 MHz

Intelligent vector voltmeter for direct measurement of complex quantities

IEC 625 Bus

Data sheet
292 401
E-1

VECTOR ANALYZER ZPV

measures and indicates directly on a digital readout:

complex voltage and voltage ratio

s parameters, impedance, admittance, reflection coefficient, VSWR, return loss, transmission factor and transfer constant

group delay and group-delay variation

delivers any desired representation:

linear or logarithmic

absolute or normalized

polar or cartesian

digital on 2 four-digit readouts, analog on 2 tendency indications, on recorders or display units via analog outputs

offers optimum operating convenience due to built-in "intelligence"

can be extended to form a calculator-controlled network analyzer system

Uses

Vector measurement Automation of test setups

The Vector Analyzer ZPV implements a completely new, elegant technique for the measurement of complex quantities. The basic unit consists of a **dual-channel vector voltmeter** measuring according to magnitude and phase and a **microprocessor-controlled analyzer section** weighting, normalizing and converting the measured voltage vectors into the desired complex quantity. Thus the ZPV outdoes conventional analog vector voltmeters in operating convenience and display possibilities. Its typical applications are control engineering, crystal, antenna and amplifier measurements, etc.

Various options permit the intelligence of the set to be matched with the requirements of the specific application. The **IEC-bus Option ZPV-B1** enables use of the ZPV in automatic test systems. The Vector Analyzer is ideal for automating test setups which are to measure the phase in addition to the voltage.

Two-port measurement

When using the **s-parameter Option ZPV-B2** the application range of the set is extended considerably. In this case, direct indication of the measured impedance, admittance, s parameter, VSWR, etc., is obtained. Elaborate mathematical transformations or aids, such as transformation diagrams, e.g. the Smith chart, are no longer required and the resulting graphic inaccuracies and possible reading errors are excluded. The desired quantity is displayed on a digital readout. The fully automatic operation of the ZPV simplifies two-port measurements such that they can also be performed by unskilled personnel.

Group-delay measurement

The **Group-delay Option ZPV-B3** permits group-delay measurement of high accuracy (down to 1 ns, typ.), the group delay or group-delay variation being directly displayed on a digital readout. When using this option, the ZPV is especially suitable for manual or automatic checking of two-port nominal characteristics, e.g. in servicing or goods outwards inspection.

Cost-effective use in two-port measurements and fully automatic test assemblies

The possibility of combining the ZPV with virtually all conventional signal generators is essential for its extremely favourable price/performance ratio. This applies in particular to two-port measurements. Since in most cases this equipment is already available, it is often sufficient to buy a ZPV for enabling network analyses and other complex measurements. To ensure fully automatic operation, the ZPV can be combined with any IEC-bus-compatible processor and the corresponding synthesizers so that fully automatic systems can be set up at a particularly economical price.

Characteristics

Great operating convenience

The clear and non-confusing front panel includes large, illuminated keys which optically indicate every device status set. These pushbuttons are arranged in function-determined groups; senseless combinations are electronically inhibited. Very legible digital displays plus alphanumerics for the dimension make for results that can be read off quickly and without error. For adjustment purposes, a quasi-analog linear indication is available, permitting adjustment points such as maxima or phase zero crossings to be found rapidly.

Amplitude and frequency autoranging

Range selection is fully automatic due to the built-in microprocessor so that the measured value can be read off directly after selecting the mode and physical unit. For swept-frequency operation and special display modes the amplitude and frequency autoranging facilities can be disconnected.

Automatically tuned filter

The ZPV incorporates an automatically tuned filter which provides for stable indication of noise-corrupted test signals. The microprocessor analyzes the stability of the signal and determines the time constant required for fluctuation-free display of the result.

Calibration at the push of a button

For complex measurements a reference plane has to be defined. This is done in the ZPV at the push of button, determining phase zero, magnitude = unity and reference characteristic impedance. These values are stored in the built-in microprocessor and maintained even when changing the test mode so that new calibration is required only if the test setup is modified. For two-port measurements it is best to use a balanced test setup so that the same calibration conditions exist for all frequencies. If the test setup is frequently changed, an adjustable short helps to obtain equal test conditions. In the case of fully automatic operation using calculator control this aid is not required since the routine is able to calculate the reference plane from the frequency information.

Microprocessor-controlled recorder outputs

Control voltages monitored by the microprocessor ensure that high-precision signals are always available at the X and Y outputs. Transient response of the synchronization stage due to sampling is suppressed. Consequently the Vector Analyzer ZPV can also be used in swept-frequency operation; however, the sweep rate of the ZPV, which is slow compared with sweeper display units, has to be considered. The test results obtained in swept-frequency checkouts can be plotted on a recorder or displayed on a storage oscilloscope up to a dynamic range of 110 dB. For narrowband sweeping, for instance in crystal testing, additional special outputs are available.

Variety of display

The two digital readouts of the ZPV indicate both components of the measured complex quantity. The display can be in cartesian or polar coordinates, linear, logarithmic, absolute or relative. For an overview of the different possibilities of test result representation see pages 4 and 5.

System compatibility

With the IEC-bus Option ZPV-B1 the ZPV becomes fully programmable. The IEC bus permits both setting of all modes on the instrument and outputting of all test results. Various methods of data transfer ensure optimum data transmission speed. In addition to the separate output of real and imaginary components or magnitude and phase, the complete complex quantity can be transmitted as one data word. The readout is either dependent on the measurement time or independent of time so that optimum use of the measurement speed is made. Manually selected modes can be output via the IEC bus. Basic Software ZPV-K1 and ZPV-K2 facilitate programming of automatic measurements with the desktop Tektronix Graphic Computing System 4051, permitting whole program sections to be called up by means of code numbers (see page 10).

Display of results on ZPV

Voltage and voltage ratio

563. mV   +030. φBA

Voltage in mV with phase indication

+08.0 dBm   +030. φBA

Level in dBm with phase indication

28.6   +030. φBA

Linear voltage ratio by magnitude and phase

-05.0 dB   +030. φBA

Logarithmic voltage ratio by magnitude and phase

24.5   +14.6 j

Voltage ratio with real and imaginary components

Impedance

+59.7 Ω   +.639 jΩ

Impedance in terms of resistance and reactance

59.8 Ω   +005. φZ

Impedance by magnitude and phase

1.22 Zo   +006. φZ

Normalized impedance by magnitude and phase

Admittance

+19.6 mS   -1.98 jmS

Admittance in terms of conductance and susceptance

16.6 mS   -063. φY

Admittance by magnitude and phase

Display of results on ZPV

Admittance

.820 Yo   +000. φY

Normalized admittance by magnitude and phase

+1.45 Yo   -.137 jYo

Normalized admittance in terms of conductance and susceptance

s parameters

.112   +031. φS

Reflection coefficients (input and output reflection coefficients s_{11} and s_{22})

-18.7 dB   +031. φS

Return loss

1.26 SWR   +031. φS

VSWR

+.096   +.059 j

s_{11} and s_{22} with real and imaginary components

28.5   -007. φS

Transmission factor (linear), s_{21} or s_{12}

+29.1 dB   -007. φS

Transfer constant (logarithmic), s_{21} or s_{12}

Group delay

19.9 mV   +2.337 µs

Group delay and voltage measurement

SWP   A<<

Narrowband sweeping with level control

Options and plug-ins
extend the **measuring capabilities** and application ranges of the ZPV.

Vector measurement

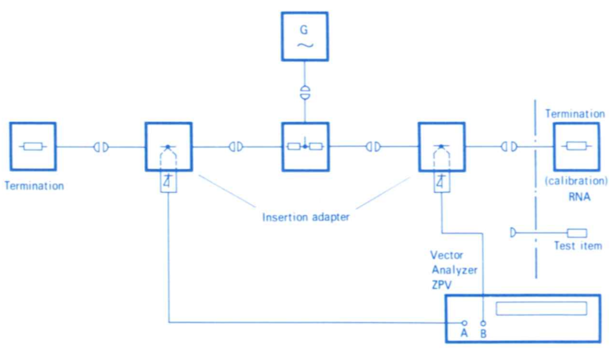
In the **basic ZPV version** the voltages in channels A and B are measured and indicated in absolute mV or dBm values and relative to any presettable reference value in dB. Simultaneously the phase difference between channels A and B is indicated. The voltage ratio between the two channels can be indicated linearly and logarithmically – both in absolute or relative values – or with its real and imaginary components.

Two-port measurement

When using the **s-parameter Option ZPV-B2,** the s parameters, impedance and admittance values can be read out on the digital ZPV display either in cartesian or in polar coordinates. Impedance and admittance are indicated both in absolute values and normalized to the characteristic impedance, the reference being either 50 or 75 Ω. The ZPV permits impedance calculation for test setups using directional couplers and bridges or based on the voltage measurement method. The type used is entered with the aid of a pushbutton.

The s parameters are read out linearly or logarithmically. Direct indication of the VSWR is also possible. The reference plane is defined at the push of a button, the reference phase and amplitude being automatically stored in the ZPV.

For two-ports in the range < 100 MHz the voltage measurement method can be used (see figure below) whereas use of an impedance-match bridge or directional couplers is to be preferred at higher frequencies (> 100 MHz) because of the increased accuracy (see figure to the right). The required accessories must be ordered separately.

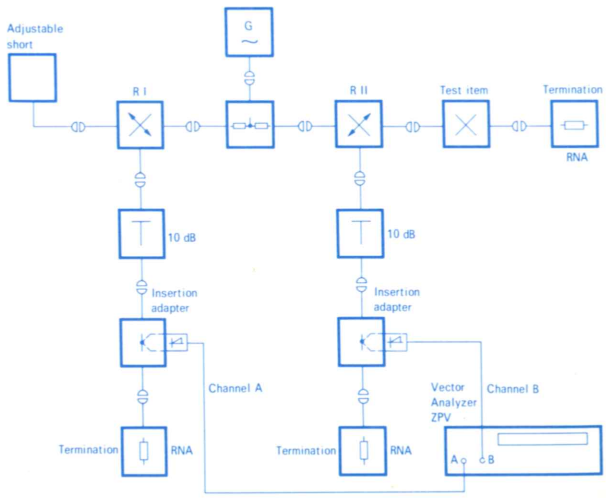


Group-delay measurement

The **Group-delay Option ZPV-B3** permits measurement of group delay and group-delay variation with high resolution (typical 1 ns). To this effect, the ZPV is combined with an FSK generator. Most FM generators are suitable for this purpose. Unmodulable generators can be used if the frequency shift is performed manually or by computer control. However, in this case the test speed is reduced. When using a calibration cable (50 ns), the FM control voltage and thus the frequency shift can be calibrated. To this end a calibration button is provided on the ZPV.

Tuner cassette

The ZPV is of **modular design.** The **Tuner ZPV-E2** covers the frequency range from 100 kHz to 1 GHz. The cassette comes with two probes enabling high-impedance voltage measurement. For checking coaxial systems, insertion adapters are available; they can be combined with the probes and also permit connection of the directional couplers. The **Tuner ZPV-E3** covers the frequency range from 0.3 to 2000 MHz. Its input is equipped with N female connectors; input impedanze 50 Ω (see data sheet 301 701).



Two-port measurement based on the voltage method using Tuner ZPV-E2 (left) and using directional couplers (right)

Automatic network analyzer with calculator control

ZPV
+ generator

When combining the Vector Analyzer ZPV with a programmable frequency generator and a calculator, a fully automatic network analyzer system is obtained. Various Rohde & Schwarz generators are suitable for this purpose.

For somewhat less stringent frequency-accuracy requirements, the Power Signal Generator SMLU can be used in the range from 25 MHz to 1 GHz. The Decade Frequency Generator SMDS permits precision measurements over the entire ZPV range. Both the normal and the receiver test versions of the Test Assembly for Radio Sets SMPU can also be used to form an automatic network analyzer.

+ calculator

For controlling the ZPV, the Tektronix Graphic Computing System 4051 is ideal; this desktop calculator gives a direct graphic display of the measured values.

+ basic software

For this combination of instruments, Rohde & Schwarz offers an easy-to-handle basic software so that a minimum of time is required to get acquainted with the application of the network analyzer. The preprogrammed measurement and display modes can be called up with code numbers (see page 11). Graphic display in particular shows the efficiency of the basic software: the curves plotted can be made available directly as hardcopy documentation (for examples of programming and graphic display see page 10).

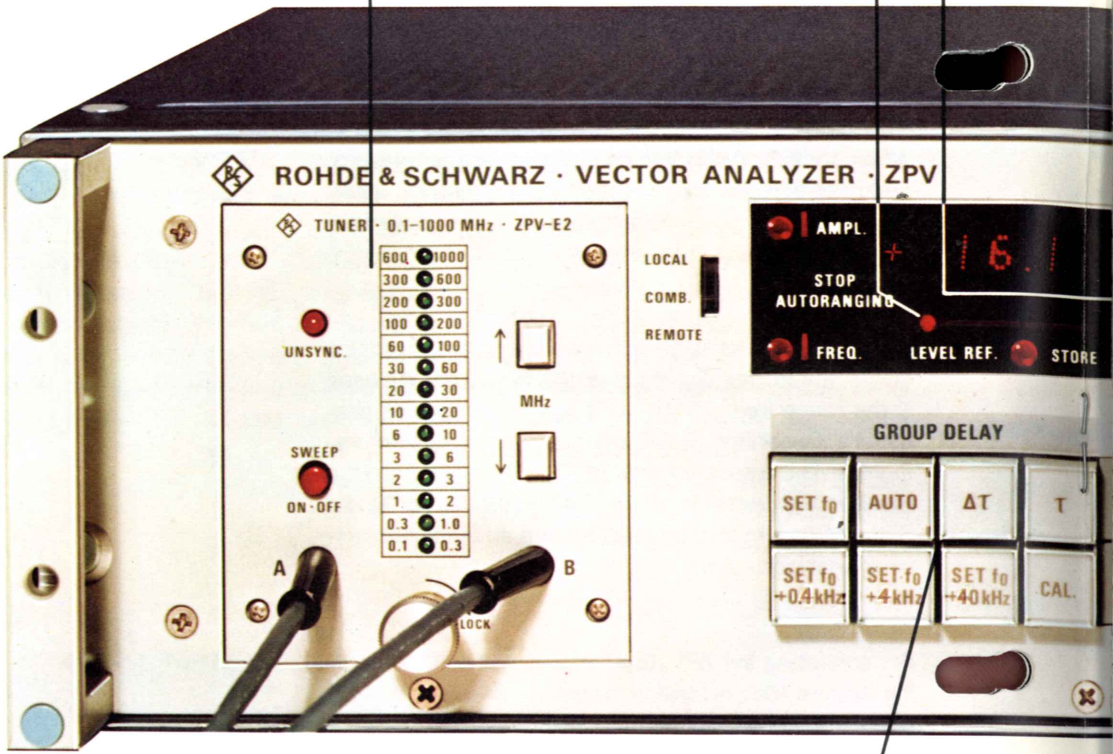
= automatic network analyzer

The resulting automatic network analyzer system (see bottom of page 10) is superior in many respects to the calculator-controlled systems used hitherto: the high intelligence of the ZPV makes operation and programming simple and easy to understand. The test speed, in particular for impedance and admittance measurements, is very high since computing and control are performed to a large extent in the ZPV at optimum speed. Only a minimum of data and control commands has to be transferred between the calculator and the peripherals.

Measurement capabilities using the automatic network analyzer

The automatic network analyzer performs all measurements possible with the ZPV in fully automatic operation. The measurement accuracy of the system corresponds to that of the ZPV. Additional calibration routines for determining and considering the inherent error of the test setup permit a considerable increase of the measurement accuracy. The total measurement time is the sum of the ZPV measuring times and the computing time of the desktop calculator.

292 401



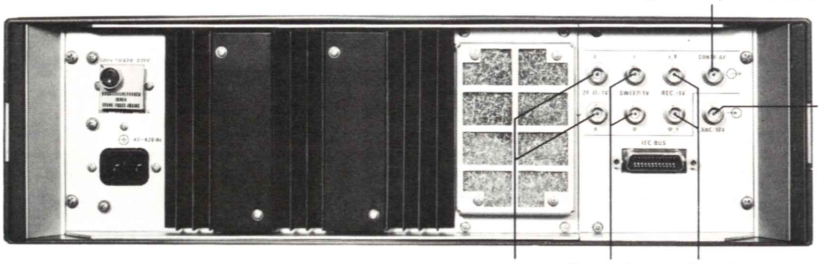
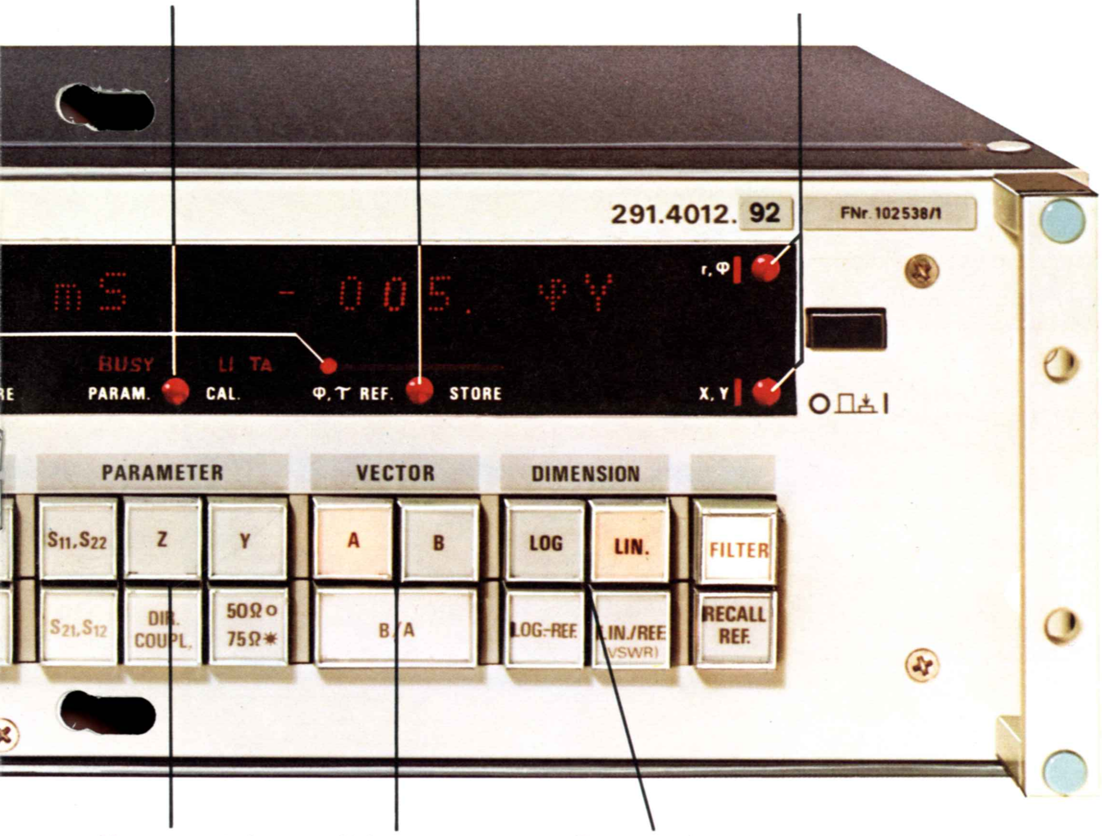


Table of setting commands

Control characters (the trailing dots stand for the numerics to be inserted)	Setting
AR ..	amplitude range
FR..	frequency range
Gϕ	tendency indication OFF
G1	tendency indication ON
HZ.....	frequency value
Kϕ	recorder output OFF
K1	recorder output ON
PO....	phase offset
SH	high measurement speed
SL	low measurement speed
TE	external triggering
TI	internal triggering
TR	reference value (10 ASCII characters)
TS	device status word (10 ASCII characters)

See also page 10 middle: example of programming for Tektronix Graphic Computing System 4051 using the Basic Software ZPV-K1.



Association of programming commands (blue) with ZPV operating controls.
Tuner, SWEEP W1 WØ

Table of output commands

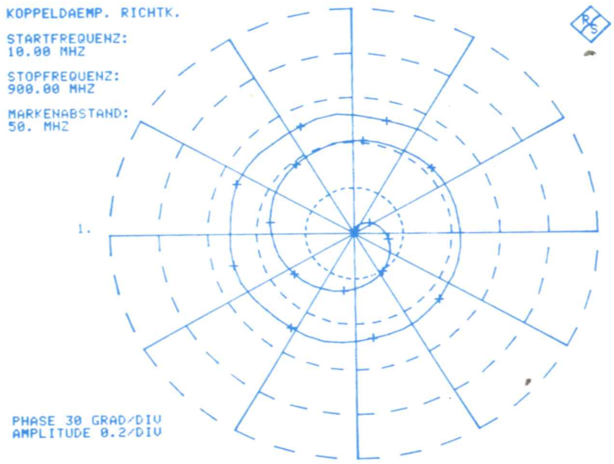
Control characters	Secondary address ASCII	Secondary address Tektronix 4051	Output
AD	h	8	DC voltage at ADC socket
DS	d	4	device status word (coded)
LR	c	3	lefthand and righthand indication
LX	a	1	lefthand indication
RA	e	5	measurement range of channel A
RB	f	6	measurement range of channel B
RF	g	7	frequency range of plug-in
RX	b	2	righthand indication
SR	i	9	reference value (coded)

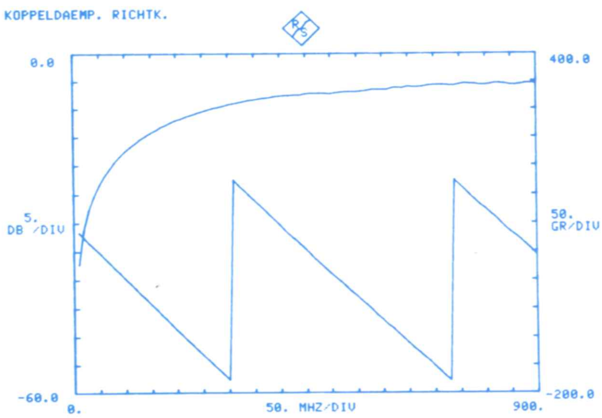
Basic software

The **Basic Software ZPV-K1** permits both easy programming of point-by-point measurements as they are required for final inspection and graphic display of continuous frequency-dependent curves (for two examples of such curves output on the hardcopy unit see to the right). There are different possibilities of outputting the test result: numerical display on the screen or by a printer and graphic display on the screen or output on a hardcopy unit. Comparing of nominal and actual values is also possible. For the tables compiling the setting and output commands see pages 8 and 9 and for the list of code numbers associated with the Basic Software ZPV-K1 page 11.

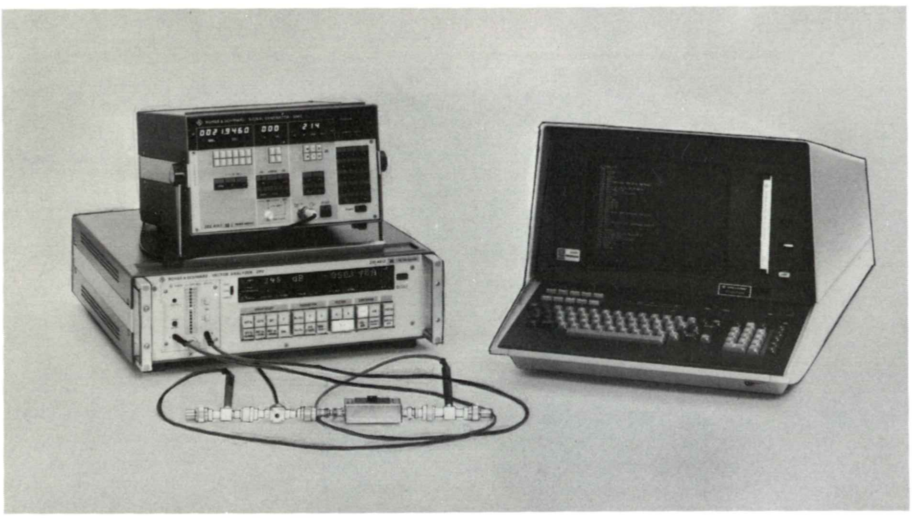
Example of programming for Tektronix Graphic Computing System 4051 using the Basic Software ZPV-K1 (see also list of code numbers associated with the basic software).

```
100 INIT
110 Y=1
120 GOSUB 1
130 Y=10
140 GOSUB 9
150 Y=900
160 GOSUB 10
170 Y=10
180 GOSUB 11
190 GOSUB 78
200 Y1=-60
210 Y2=0
220 S$="DB"
230 T$="KOPPELDAEMP. RICHTK."
240 GOSUB 90
250 GOSUB 97
260 Y1=-200
270 Y2=400
280 Y$="GR"
290 GOSUB 92
300 GOSUB 98
310 END
```





Coupling attenuation of a directional coupler represented in polar coordinates (top) and in cartesian coordinates (bottom); output on hardcopy unit (heavily reduced scale); for the associated programming example see to the left.



Automatic test assembly for s-parameter measurement with the aid of Vector Analyzer ZPV.

Basic software

Code numbers of Basic Software ZPV-K1

1 program start	Y = 1 generator SMPU
	Y = 2 generator SMLU
	Y = 3 generator SMDS
	Y = 4 generator SMS

Input data	Physical unit
2 test frequency	MHz
3 test level	dBm
6 shift of reference plane	cm
7 relative dielectric constant ε	
9 sweep start frequency	MHz
10 sweep stop frequency	MHz
11 sweep step width	MHz
13 number of markers	
14 frequency deviation for group-delay measurement	kHz

Operational settings
17 impedance of test setup 50 Ω
18 impedance of test setup 75 Ω
19 parameter measurement using directional couplers
21 parameter measurement without directional couplers
22 filter on
23 filter off
25 electrical length compensation on
26 electrical length compensation off

Calibration/reference values
27 store magnitude (real component) as reference value
29 store phase (imaginary component), group delay as reference value
30 calibrate parameter
31 calibrate for dynamic group delay measurement

Output of single-shot measurements

33 nominal/actual value comparison, output on display	H1 = upper limit of magnitude (real component) H2 = upper limit of phase (imaginary component) L1 = lower limit of magnitude (real component) L2 = lower limit of phase (imaginary component)
34 nominal/actual value comparison, output on printer	limit input same as under 33

Output of swept-frequency measurements

35 nominal/actual value comparison, output on display	limit input same as under 33
37 nominal/actual value comparison, output on printer	limit input same as under 33

Program execution
39 wait loop 1 s
41 wait loop 0.1 s
42 halt
43 print program

Individual measurements

Vector measurement		Physical unit
45 voltage measurement channel A	linear	mV, degrees
46 voltage measurement channel A	linear, relative	no dimension, degrees
47 voltage measurement channel A	log	dBm, degrees
49 voltage measurement channel A	log, relative	dB, degrees
50 voltage measurement channel B	linear	mV, degrees
51 voltage measurement channel B	linear, relative	no dimension, degrees
53 voltage measurement channel B	log	dBm, degrees
54 voltage measurement channel B	log, relative	dB, degrees
55 voltage ratio measurement, channel B/A	linear	no dimension, degrees
57 voltage ratio measurement, channel B/A	linear, relative	no dimension, degrees
58 voltage ratio measurement, channel B/A	log	dB, degrees
59 voltage ratio measurement, channel B/A	log, relative	dB, degrees
Parameter measurement		
62 reflection coefficient measurement	linear by magnitude and phase	no dimension, degrees
63 reflection coefficient measurement	linear with real and imaginary components	no dimension
65 reflection coefficient measurement	log by magnitude and phase	dB, degrees
66 VSWR measurement		no dimension, degrees
67 impedance measurement by magnitude and phase		Ω, degrees
69 impedance measurement in terms of resistance and reactance		Ω
73 admittance measurement by magnitude and phase		mS, degrees
74 admittance measurement in terms of conductance and susceptance		mS
75 transmission factor measurement	linear by magnitude and phase	no dimension, degrees
77 transmission factor measurement	linear with real and imaginary components	no dimension
78 transmission factor measurement	log by magnitude and phase	dB, degrees
Group-delay measurement		
82 static group-delay measurement		µs
83 dynamic group-delay measurement		µs
DC voltage measurement		
84 voltage measurement at ADC input		V

Graphic display

Charts	
85 Smith chart	T$ = "(title, max. 20 characters)"
86 Smith chart + 10 dB	T$ = "(title, max. 20 characters)"
87 Smith chart – 10 dB	T$ = "(title, max. 20 characters)"
88 polar diagram	Y = outer circle T$ = "(title, max. 20 characters)"
89 additional scaling, polar	Y = outer circle
90 cartesian diagram, linear frequency axis	Y1 = minimum vertical axis Y2 = maximum vertical axis S$ = "(unit, max. 3 characters)" T$ = "(title, max. 20 characters)"
91 cartesian diagram, log frequency axis	input same as under 90
92 additional scaling, cartesian	input same as under 90

Graphic data output
96 in Smith chart or polar coordinates
97 magnitude (real component) in cartesian coordinates
98 phase (imaginary component, group delay) in cartesian coordinates

Specifications

ZPV BASIC UNIT WITH OPTIONS

Display of measured quantities

Vector measurement

Ⓟ Polar-coordinate representation

Magnitude of voltage (channel A or B)

Lin indication	3 digits with floating decimal point, max. resolution 1 µV
Log indication (absolute) in dBm (0 dBm corresponding to 1 mW into 50 Ω)	4 digits, resolution 0.1 dB
Log indication (relative) in dB	4 digits, resolution 0.1 dB (for values <1 dB: 0.01 dB)
Indication of reference value for relative voltage measurements in dBm	4 digits, resolution 0.1 dB

Magnitude of ratio

Lin indication	3 digits with floating decimal point, max. resolution 0.001
Log indication	4 digits, resolution 0.1 dB

Phase

Readout in degrees	4 digits, resolution 0.1°
Range	–180 to +180°
Indication of phase reference value in degrees	4 digits, resolution 0.1°

Ⓒ Cartesian-coordinate representation

Lin indication	3 digits with floating decimal point, max. resolution 0.001
Calibration of reference phase and level	automatic by pushbutton

s-parameter measurement (option ZPV-B2)

Test method	for frequencies <100 MHz: direct voltage measurement for frequencies >100 MHz: use of directional coupler or impedance-match bridge
Calibration of reference phase and level	automatic by pushbutton
Characteristic impedance	50 Ω/75 Ω, switch-selected

Ⓟ Polar-coordinate representation

Lin indication of magnitude	3 digits with floating decimal point, max. resolution 0.001
Log indication of magnitude	4 digits, resolution 0.1 dB
Indication of phase in degrees	4 digits, resolution 0.1°
VSWR	4 digits with floating decimal point

Ⓒ Cartesian-coordinate representation

Lin indication	3 digits with floating decimal point, max. resolution 0.001

Impedance or admittance measurement (option ZPV-B2)

Characteristic impedance	50 Ω/75 Ω, switch-selected

Ⓟ Polar-coordinate representation

Absolute indication of magnitude in Ω or mS	3 digits with floating decimal point, max. resolution 0.1 Ω or 0.1 mS
Normalized indication of magnitude	4 digits, resolution 0.01
Indication of phase in degrees	4 digits, resolution 0.1°

Ⓒ Cartesian-coordinate representation

Normalized indication	3 digits with floating decimal point, max. resolution 0.01
Absolute indication in Ω or mS	3 digits with floating decimal point, max. resolution 0.1 Ω or 0.1 mS

Group-delay measurement (option ZPV-B3)

Indication	3 digits with floating decimal point, max. resolution 1 ns
Frequency shift	0.4/4/40 kHz, switch-selected
Measured quantities	group delay and group-delay variation
Modes	single-shot and continuous measurement

Programming (option ZPV-B1)

System	IEC 625-1 (IEEE 488)
Connector	24-way Amphenol

Interface functions

T6, TE6	talker capability with secondary address, series polling and automatic unaddressing
L4	listener capability with automatic unaddressing
SR1	service request (switch-selected)
DC1	device clear
DT1	device trigger

Specifications

Timing (typical values)

Time required for addressing	1 µs
Time required for data transfer	0.5 to 2 ms
Period between reception of talker address and output of first data word	0.5 ms
Max. data output time	0.5 ms

Code	ISO 7-bit
Figure representation	decimal

Limit characters	16 different characters can be set (factory setting: CR)

Test outputs

X and Y outputs for recorder

Output-voltage range	0 to +1.25 V DC
Output impedance	1 kΩ
Connector	BNC

r and φ output for narrowband sweeping

Output voltage range r	0 to 1 V DC
Output voltage range φ	−0.5 to +0.5 V
Output impedance	1 kΩ
Test bandwidth	1 kHz (15 Hz for ≦100 µV in channel B)
Connector	BNC

IF outputs for channels A and B

Output frequency	20 kHz
Output level	AC input level on probe
Output impedance	1 kΩ
Connector	BNC

DC voltage test input

Input voltage range	0 to +10 V, resolution 2.5 mV
Input impedance	>100 kΩ
Connector	BNC

General data (basic unit)

Nominal temperature range	+10 to +45 °C
Shelf temperature range	−40 to +75 °C
AC supply	115/125/220/235 V ±10 %, 47 to 420 Hz (90 VA)
Overall dimensions (W × H × D)	492 mm × 161 mm × 514 mm
Weight (including options and Tuner ZPV-E2)	16 kg
Colour	front panel: light grey RAL 7001; panelling: grey blue RAL 7011
Panel inscriptions	English

For **order designation** see pages 15 and 16

ZPV PLUS TUNER ZPV-E2

(accuracy data applicable for set with frequency autoranging facility disabled)

Frequency range	0.1 to 1000 MHz
Subranges (14)	0.1 to 0.3 to 1 to 2 to 3 to 6 to 10 to 20 to 30 to 60 to 100 to 200 to 300 to 600 to 1000 MHz
Subrange overlap	typically 10 %
Range setting	automatic or manual
Tuning within subrange	automatic
Hold range	0.2 to 0.4 MHz at f <1 MHz 1 to 3 MHz at f = 1 to 1000 MHz
Maximum sweep rate for tracking within hold range	0.3 to 3 MHz/s for f <1 MHz 3 to 30 MHz/s for f = 1 to 1000 MHz
Input impedance of probes	60 kΩ ll 2 pF
with 100 : 1 divider	6 MΩ ll 2 pF
Maximum input voltage	3 V AC, ±50 V DC
Crosstalk attenuation referred to signals at probe tips	≧100 dB at f = 0.1 to 500 MHz ≧80 dB at f = 500 to 1000 MHz

Sensitivity and input level

	Sensitivity	Input level	Frequency range
Channel A	1200 µV (400 µV typical)	max. 0.3 V	0.1 to 1 MHz
	400 µV (150 µV typical)	max. 1 V	1 to 1000 MHz
Channel B	3 µV (1 µV typical)	max. 0.3 V	0.1 to 1 MHz
	3 µV (1 µV typical)	max. 1 V	1 to 1000 MHz

Additional error with 100 : 1 divider	±6 % at f = 1 to 200 MHz

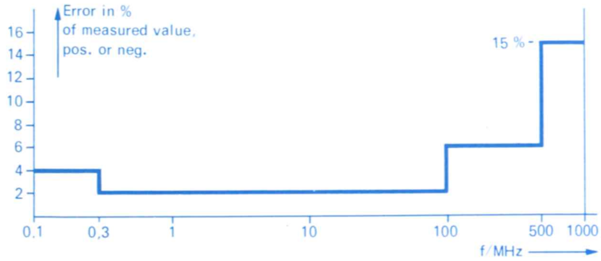
Specifications

ZPV PLUS TUNER ZPV-E2 (contd)

Vector measurement [1]

Ⓟ Polar-coordinate representation

Magnitude of voltage (channel A or B)



Error of voltage measurement with a constant input level of 100 mV (absolute measurement)

Magnitude of ratio	
Measurement range	–90 to +70 dB within the permissible input levels
Indication error at fixed frequency[2]	
with calibration button (linearity)	±1.5 %
without calibration button (difference between A and B)	±3 % at f = 0.1 to 100 MHz ±6 % at f = 100 to 1000 MHz
Phase	
Measurement range	–180 to +180°
Linearity error	<0.5° at fixed frequency and 2 × 100 mV at probe tips
Effect of frequency variation (reference frequency 10 MHz)	<±3° at f = 0.1 to 0.3 MHz <±1° at f = 0.3 to 100 MHz <±4° up to f = 500 MHz <±6° up to f = 1000 MHz
Effect of level variation[2]	<0.05°/dB <3° over entire range

Ⓒ Cartesian-coordinate representation

Measurement range	–90 to +70 dB within the permissible input levels
Error of polar-to-cartesian conversion	<0.1 %

s-parameter measurement

Measurement ranges and errors	see vector measurement of magnitude of ratio and phase; errors and ranges of directional couplers must be taken into acccunt
Reflection measurement range with Directional Coupler ZPV-Z3	–45 to +10 dB

Impedance or admittance measurement

Measurement error	see vector measurement of magnitude of ratio and phase
Range of impedance measurement with Directional Coupler ZPV-Z3	approx. 5 to 500 Ω in 50-Ω systems or approx. 7.5 to 750 Ω in 75-Ω systems

Group-delay measurement [1]

Frequency shift 40 kHz	
Range	1 to 10,000 ns, resolution 1 ns
Measurement error (for V_{in} > 30 mV) (V_{in} = voltage in channels A and B)	<±3 % ±3 ns (from 1 MHz)
Frequency shift 4 kHz	
Range	10 ns to 100 μs, resolution 10 ns
Measurement error (for V_{in} > 30 mV)	<±3 % ±30 ns (from 1 MHz)
Frequency shift 400 Hz	
Range	100 ns to 1 ms, resolution 100 ns
Measurement error (for V_{in} > 30 mV)	<±3 % ±300 ns (from 1 MHz)

[1]) Measured in 50-Ω system or with isolator

[2]) For additional measurement error due to crosstalk see crosstalk attenuation (page 13)

Specifications

Timing

Time required for	
synchronization	<20 ms
complex vector or s-parameter measurement (synchronization time not included)	30 ms for levels >100 μV 80 ms for levels <100 μV
complex impedance measurement (synchronization time not included)	50 ms for levels >100 μV 100 ms for levels <100 μV
automatic group-delay measurement (synchronization time not included)	150 ms for levels >30 mV (without filter) 400 ms for levels >30 mV (with filter)

General data

Nominal temperature range	+18 to +30 °C
Operating temperature range	+10 to +45 °C

ZPV PLUS TUNER ZPV-E3 see data sheet 301 701

Frequency range 0.3 to 2000 MHz

AUTOMATIC NETWORK ANALYZER (ZPV plus Tektronix Graphic Computing System 4051 and Decade Frequency Generator SMDS or Test Assembly for Radio Sets SMPU)

Frequency range	0.1 to 1000 MHz 10 to 1000 MHz when using directional couplers
Resolution up to 500 MHz	10 Hz
up to 1000 MHz	20 Hz
Measurement capabilities	voltage lin or log, vectors in polar or cartesian coordinates; s parameters; impedance/admittance; group delay
Dynamic range	–90 to +70 dB
Minimum input level	3 μV
Display	digital and graphic
Time required	
for display of complete locus	10 to 20 s (about 50 measuring points)
for complex measurement	200 ms for levels >100 μV
Programming	IEC bus (IEEE 488)

Order designations

ZPV basic unit without tuner and without options	▶ Vector Analyzer ZPV 291.4012.92
including power cable 025.2365.00 manual	
Tuner (100 kHz to 1 GHz) without options	▶ Tuner ZPV-E2 292.0010.02
including 2 BNC adapters 237.5650.00 3 ground terminals 237.5150.00 2 insulators 237.5020.02 2 100:1 dividers 237.2550.02 1 probe tip 237.5520.00 1 accessory case 292.0827.00 manual	
Tuner (300 kHz to 2 GHz) without options	▶ Tuner ZPV-E3 301.7018.00
IEC bus option	▶ IEC-bus Option ZPV-B1 292.3610.02
including IEC bus cable PCK (2 m) 292.2013.20	
s-parameter option	▶ s-parameter Option ZPV-B2 292.3810.02
Group-delay option	▶ Group-delay Option ZPV-B3 292.3910.02
including calibration cable (50 ns) 292.4000.00	

Order designations (contd)

Recommended extras

Insertion Adapter ZPV-Z1 (at least two units required)	292.2713.50 (for coaxial measurements)
Connectors: N socket/plug	
Feed Unit ZPV-Z2, 50 Ω	292.2913.50
Connectors: generator – BNC others – N female	
Directional Coupler ZPV-Z3, 45 dB, 50 Ω (at least two units required)	292.3110.50
Connectors: RF input – N male test item – N female test output – N female	
Directional Coupler ZWD-Z, 50 dB, 75 Ω Dez. A and B	219.6270.70
Precision Termination RNA (0 to 12 GHz, 0.3 W, 50 Ω, N male connector)	272.4510.50
Termination RNB (0 to 4 GHz, 1 W, 50 Ω, N male connector)	272.4910.50
Attenuator DNF (10 dB, 50 Ω, N male connector)	272.4210.50
Attenuator DNF (20 dB, 50 Ω, N male connector)	272.4310.50
Shortcircuit N male connector, 50 Ω	017.8080.00
VSWR Bridge ZRB (5 to 2000 MHz, 50 Ω, 46 dB)	335.2819.50
VSWR Bridge SWOB4-Z (10 to 1000 MHz, 50 Ω)	912.7003.00
VSWR Bridge SWOB4-Z (10 to 1000 MHz, 75 Ω)	912.7303.00
AM/FM Signal Generator SMLH (10 kHz to 40 MHz)	283.8070.52
Power Signal Generator SMLU (25 to 1000 MHz)	200.1009.02
Decade Frequency Generator SMDS (10 kHz to 1000 MHz)	154.8723.52
Signal Generator SMDU, standard model 02 (0.14 to 525/1000 MHz)	249.3011.02
Signal Generator SMDU, universal model 04 (0.14 to 525/1000 MHz)	249.3011.04
Test Assembly for Radio Sets SMPU, model 52 (50 kHz to 500/1000 MHz)	239.0010.52
Signal Generator SMS (0.4 to 520/1040 MHz)	302.4012.02

For sweep operation

Sweep Unit SMLU-Z for Power Signal Generator SMLU, Signal Generator SMDU (model 04) or AM/FM Signal Generator SMLH	243.3010.92
XY Recorder ZSK 2, standard model 04 (XY operation only)	290.2016.04
XY Recorder ZSK 2, lab model 06 with timebase (XY and YT operation)	290.2016.06
1 set of diagrams DIN A3 with Smith, Carter and polar-coordinate charts, expanded and not expanded	274.1619.02
Precision LF Generator SSN	204.8014.52

Equipment and accessories for extending the ZPV to a fully automatic network analyzer system

Decade Signal Generator SMDS (10 kHz to 1000 MHz)	154.8723.52
Code Converter PCW	244.8015.92
Coding Board PCW-Z for PCW for use with SMDS	245.2810.02
Power Signal Generator SMLU (25 to 1000 MHz)	200.1009.03
Frequency Controller SMLU-Z3 for SMLU	242.5019.92
Code Converter PCW	244.8015.92
Coding Board PCW-Z for PCW for use with SMLU	245.2610.02
Test Assembly for Radio Sets SMPU (receiver test assembly) (50 kHz to 500/1000 MHz)	239.0010.54
1-GHz Generator Extension SMPU-B1	240.7014.02
Signal Generator SMS (0.4 to 520/1040 MHz)	302.4012.02
Cables for IEC bus PCK, 0.5 m	292.2013.05
1 m	292.2013.10
2 m	292.2013.20
4 m	292.2013.40

Basic Software (cartridge and manual)

for TEK 4051 or 4052	ZPV-K1	292.2113.02
for HP 9835	ZPV-K4	292.2413.02
for Commodore PET	ZPV-K7	291.8518.02

S-parameter Accuracy-improvement Software (cartridge and manual)

for TEK 4051 or 4052	ZPV-K2	292.2213.02
for HP 9835	ZPV-K5	292.2513.02
for Commodore PET	ZPV-K8	291.8618.02

S-parameter Test Adapter (see data sheet 335111)	ZPV-Z5	335.1112.50

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ROHDE & SCHWARZ GmbH & Co. KG · D-8000 München 80 · Mühldorfstr. 15 · Tel. (089) 41 29-1 Int. +49 89 41 29-1 · Telex 523 703
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