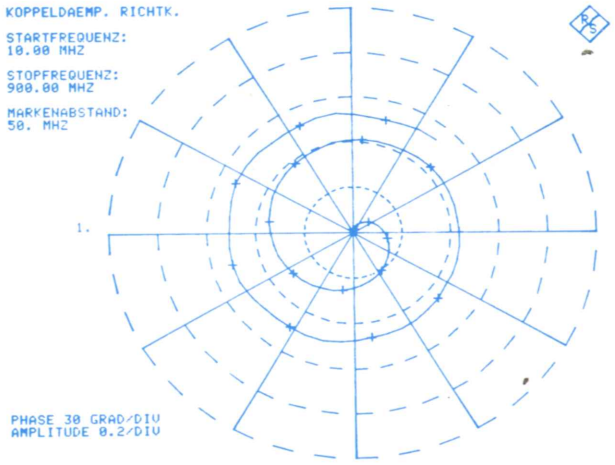
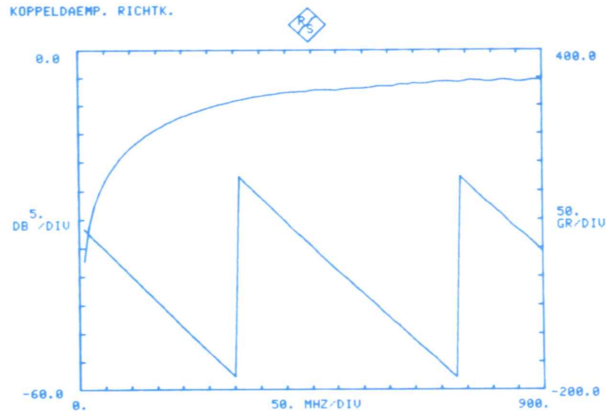
Basic software

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.

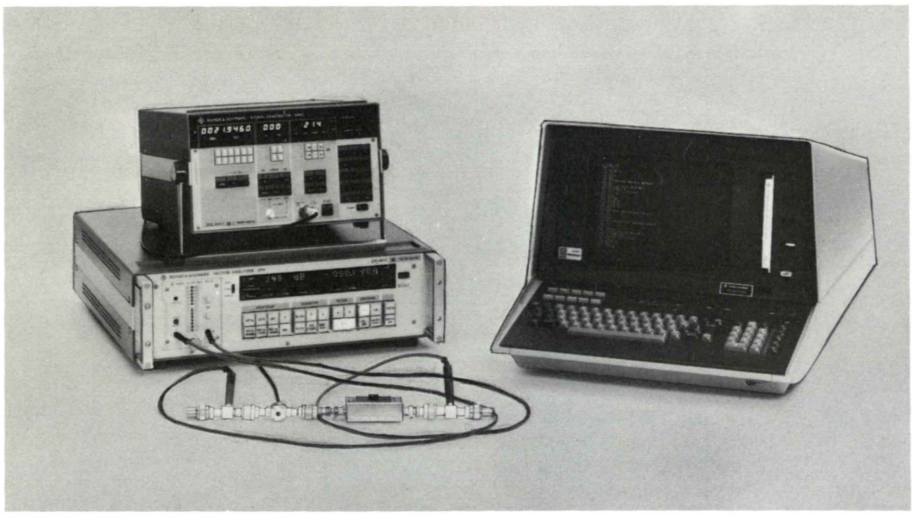
Example of programming for Tektronix Graphic Computing System 4051 using the Basic Software ZPV-K1 (see also list of code numbers associated with the basic software).

```
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

Vector measurement		Physical unit
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 $\leqq$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 II 2 pF
with 100 : 1 divider	6 MΩ II 2 pF
Maximum input voltage	3 V AC, ±50 V DC
Crosstalk attenuation referred to signals at probe tips	$\geqq$ 100 dB at f = 0.1 to 500 MHz $\geqq$ 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

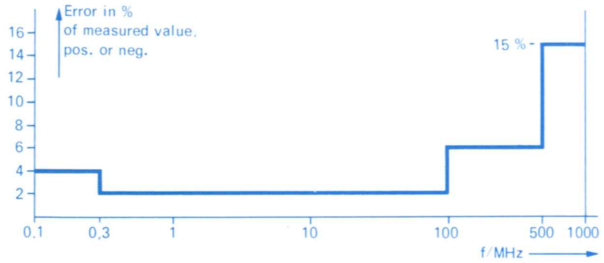
Specifications

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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