Specifications

Unless otherwise stated, specifications apply to test ports PORT1 and PORT2, a nominal source power of –10 dBm at the port and an IF bandwidth ≤10 kHz.

The arrow marks important data.

Measurement range

Frequency range

Without *External Measurements option*	
ZVRE, ZVR	
with passive SWR bridges	
50 Ω or 75 Ω	9 kHz to 4 GHz
with active SWR bridges	
50 Ω or 75 Ω	300 kHz to 4 GHz
ZVCE, ZVC	
with passive SWR bridges, 50 Ω	20 kHz to 8 GHz
with active SWR bridges, 50 Ω	300 kHz to 8 GHz
with active couplers, 50 Ω	20 kHz to 8 GHz
With *External Measurements option*	
ZVRE, ZVR	10 Hz to 4 GHz
ZVCE, ZVC	20 kHz to 8 GHz
Frequency uncertainty	$4 \times 10^{-6} + 1 \times 10^{-6}/a$
Resolution	10 µHz

Measurement speed (above 2 MHz)

	IF bandwidth (IFBW)		
Number of points	1 to 2001 (selectable)		
Measurement time per point	**3 kHz**	**10 kHz**	**26 kHz**
with system error correction	<1080 µs	<480 µs	<360 µs
normalized	<540 µs	<240 µs	<210 µs
in fast mode			
with system error correction	–	–	<240 µs
normalized	–	–	<125 µs

Dynamic range (without system error correction)
(The dynamic range is defined as the difference between the maximum source power and the peak value displayed after smoothing the measured trace for the transmission magnitude with an aperture of 1%, which is caused by inherent noise and crosstalk with test ports short-circuited.)

ZVRE, ZVR
(ZVRE: at IF bandwidth 10 Hz values are reduced by 5 dB)

	IF bandwidth		
With passive SWR bridges, 50 Ω	**10 Hz**	**3 kHz**	**10 kHz**
20 kHz to 200 kHz	>65 dB, typ. >110 dB	–	–
200 kHz to 20 MHz	>110 dB	>90 dB	>85 dB
20 MHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>90 dB	>85 dB
With active SWR bridges, 50 Ω			
300 kHz to 1 MHz	>107 dB	>87 dB	>82 dB
1 MHz to 20 MHz	>110 dB	>90 dB	>85 dB
20 MHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>90 dB	>85 dB
With passive SWR bridges, 75 Ω			
20 kHz to 200 kHz	>50 dB, typ. >95 dB	–	–
200 kHz to 20 MHz	>95 dB	>75 dB	>70 dB
20 MHz to 4 GHz	>105 dB	>85 dB	>80 dB
With active SWR bridges, 75 Ω			
300 kHz to 1 MHz	>95 dB	>75 dB	>70 dB
1 MHz to 20 MHz	>105 dB	>85 dB	>80 dB
20 MHz to 4 GHz	>102 dB	>80 dB	>75 dB
With *External Measurements* option			
50 Hz to 200 kHz	>75 dB	–	–
200 kHz to 20 MHz	>110 dB	>95 dB	>90 dB
20 MHz to 1 GHz	>130 dB	>110 dB	>105 dB
1 GHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>95 dB	>90 dB

ZVCE, ZVC
(model ZVCE: at IF bandwidth 10 Hz values are reduced by 5 dB)

	IF bandwidth		
With passive SWR bridges, 50 Ω	**10 Hz**	**3 kHz**	**10 kHz**
20 kHz to 200 kHz	>50 dB, typ. >80 dB	–	–
200 kHz to 20 MHz	>90 dB	>70 dB	>65 dB
20 MHz to 3 GHz	>110 dB	>90 dB	>85 dB
3 GHz to 4 GHz	>100 dB	>80 dB	>75 dB
4 GHz to 6 GHz	>95 dB	>75 dB	>70 dB
6 GHz to 8 GHz	>90 dB	>70 dB	>65 dB
With active SWR bridges, 50 Ω			
300 kHz to 20 MHz	>95 dB	>75 dB	>70 dB
20 MHz to 3 GHz	>115 dB	>95 dB	>90 dB
3 GHz to 4 GHz	>105 dB	>85 dB	>80 dB
4 GHz to 6 GHz	>100 dB	>80 dB	>75 dB
6 GHz to 8 GHz	>95 dB	>75 dB	>70 dB
With active couplers, 50 Ω			
20 kHz to 200 kHz	>60 dB, typ. >90 dB	–	–
200 kHz to 20 MHz	>100 dB	>80 dB	>75 dB
20 MHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>90 dB	>85 dB
4 GHz to 6 GHz	>105 dB	>85 dB	>80 dB
6 GHz to 8 GHz	>100 dB	>80 dB	>75 dB
With *External Measurements* option			
20 kHz to 200 kHz	>75 dB	–	–
200 kHz to 20 MHz	>110 dB	>95 dB	>90 dB
20 MHz to 1 GHz	>130 dB	>110 dB	>105 dB
1 GHz to 3 GHz	>120 dB	>100 dB	>95 dB
3 GHz to 4 GHz	>110 dB	>95 dB	>90 dB
4 GHz to 6 GHz	>105 dB	>90 dB	>85 dB
6 GHz to 8 GHz	>100 dB	>85 dB	>80 dB

Crosstalk between measurement channels with total reflection at test ports (values for 75 Ω models and ZVC/E models with SWR bridges are 6 dB higher)

	ZVRL, ZVRE, ZVCE	ZVR, ZVC
20 kHz to 200 kHz	<–90 dB, typ. <–110 dB	
200 kHz to 5 MHz	<–120 dB	
5 MHz to 1 GHz	<–125 dB	<–130 dB
1 GHz to 3 GHz	<–115 dB	<–120 dB
3 GHz to 4 GHz	<–105 dB	<–110 dB
4 GHz to 6 GHz (ZVCE, ZVC)	<–100 dB	<–105 dB
6 GHz to 8 GHz (ZVCE, ZVC)	<–95 dB	<–100 dB

Stability of measurement trace at 0 dB per degree temperature variation

ZVRE, ZVR	<0.05 dB or 0.4°
ZVCE, ZVC	<0.1 dB or 1°

Measurement bandwidth
(IF bandwidth IFBW) 1 Hz to 10 kHz (half-decade steps) and 26 kHz (full)

Measurement accuracy

These data are valid between 20°C and 30°C, provided the instrument has reached thermal equilibrium (about 1 h after switch-on) and the temperature variation is not more than 1 degree after calibration.

ZVRE and ZVR (bidirectional network analyzers)

Accuracy of transmission measurements

after full two-port system error correction (TOSM)

Specifications are based on a matched DUT and refer to a nominal source power of –10 dBm at the test port.

Test set 50 Ω (active or passive SWR bridges available)
20 kHz to 300 kHz (passive SWR bridges only)
at 10 Hz IF bandwidth

for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –20 dB (typ. –55 dB)	<0.2 dB or 2°
for –20 dB to –30 dB (typ. –65 dB)	<0.5 dB or 4°
for –30 dB to –45 dB (typ. –80 dB)	<1 dB or 6°

300 kHz to 4 GHz

at 10 Hz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –60 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –60 dB (active)	<0.2 dB or 1°
for +3 dB to –40 dB	typ. <0.025 dB
for –60 dB to –70 dB	<0.2 dB or 1°
for –70 dB to –80 dB (ZVRE)	<1 dB or 6°
for –70 dB to –85 dB (ZVR)	<1 dB or 6°
at 3 kHz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –40 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –40 dB (active)	<0.2 dB or 1°
for –40 dB to –50 dB	<0.2 dB or 1°
for –50 dB to –60 dB (ZVRE)	<1 dB or 6°
for –50 dB to –65 dB (ZVR)	<1 dB or 6°
at 10 kHz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –35 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –35 dB (active)	<0.2 dB or 1°
for –35 dB to –45 dB	<0.2 dB or 1°
for –45 dB to –55 dB (ZVRE)	<1 dB or 6°
for –45 dB to –60 dB (ZVR)	<1 dB or 6°

Test set 75 Ω (active or passive SWR bridges available)
20 kHz to 300 kHz (passive SWR bridges only)

at 10 Hz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB (typ. –40 dB)	<0.2 dB or 2°
for –5 dB to –15 dB (typ. –50 dB)	<0.5 dB or 4°
for –15 dB to –30 dB (typ. –65 dB)	<1 dB or 6°

300 kHz to 4 GHz

at 10 Hz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –45 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –45 dB (active)	<0.2 dB or 1°
for –45 dB to –55 dB	<0.2 dB or 1°
for –55 dB to –65 dB (ZVRE)	<1 dB or 6°
for –55 dB to –70 dB (ZVR)	<1 dB or 6°
at 3 kHz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –25 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –25 dB (active)	<0.2 dB or 1°
for –25 dB to –35 dB	<0.2 dB or 1°
for –35 dB to –45 dB (ZVRE)	<1 dB or 6°
for –35 dB to –50 dB (ZVR)	<1 dB or 6°
at 10 kHz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –5 dB	<0.2 dB or 1°
for –5 dB to –20 dB (passive)	<0.05 dB or 0.4°[1)]
for –5 dB to –20 dB (active)	<0.2 dB or 1°
for –20 dB to –30 dB	<0.2 dB or 1°
for –30 dB to –40 dB (ZVRE)	<1 dB or 6°
for –30 dB to –45 dB (ZVR)	<1 dB or 6°

ZVRE and ZVR – Accuracy of reflection measurements

after system error correction (TOSM or full one-port)

Specifications are based on an isolating DUT and refer to a nominal source power of –10 dBm at the test port.

Test set 50 Ω (active or passive SWR bridges available)
It is assumed that the return loss of match used for calibration is >46 dB (effective system data: directivity D_{eff} >46 dB, test port match S_{eff} >30 dB).
20 kHz to 4 GHz (passive SWR bridges),
300 kHz to 4 GHz (active SWR bridges)

for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –15 dB	<0.4 dB + 0.04 dB·f/GHz, <3° + 0.4°·f/GHz
for –15 dB to –25 dB	<1 dB or 6°
for –25 dB to –35 dB	<3 dB or 20°

Test set 75 Ω (active or passive SWR bridges available)
It is assumed that the return loss of the match used for calibration is >40 dB (effective system data: directivity D_{eff} >40 dB, test port match S_{eff} >26 dB).
20 kHz to 4 GHz (passive SWR bridges),
300 kHz to 4 GHz (active SWR bridges)

for +10 dB to +3 dB	<1.5 dB or 10°
for +3 dB to –10 dB	<0.7 dB + 0.04 dB·f/GHz, <5° + 0.4°·f/GHz
for –10 dB to –20 dB	<1 dB or 6°
for –20 dB to –30 dB	<3 dB or 20°

ZVCE and ZVC (bidirectional network analyzers)

Accuracy of transmission measurements

after full two-port system error correction (TOSM)

Analyzers with SWR bridges

Specifications are based on a matched DUT and refer to a nominal source power of –10 dBm at the test port.

300 kHz to 4 GHz

at 10 Hz IF bandwidth	
for +3 dB to –60 dB	<0.2 dB or 1°
for +3 dB to –40 dB	typ. <0.025 dB
for –60 dB to –70 dB	<0.2 dB or 1°
for –70 dB to –80 dB (ZVCE)	<1 dB or 6°
for –70 dB to –85 dB (ZVC)	<1 dB or 6°
at 3 kHz IF bandwidth	
for +3 dB to –40 dB	<0.2 dB or 1°
for –40 dB to –50 dB	<0.2 dB or 1°
for –50 dB to –55 dB (ZVCE)	<1 dB or 6°
for –50 dB to –60 dB (ZVC)	<1 dB or 6°
at 10 kHz IF bandwidth	
for +3 dB to –35 dB	<0.2 dB or 1°
for –35 dB to –45 dB	<0.5 dB or 4°
for –45 dB to –55 dB (ZVCE)	<1 dB or 6°
for –45 dB to –60 dB (ZVC)	<1 dB or 6°

4 GHz to 8 GHz

at 10 Hz IF bandwidth	
for +3 dB to –35 dB	<0.2 dB or 2°
for +3 dB to –30 dB	typ. <0.025 dB
for –35 dB to –45 dB (ZVCE)	<1 dB or 6°
for –35 dB to –50 dB (ZVC)	<1 dB or 6°
at 3 kHz IF bandwidth	
for +3 dB to –15 dB	<0.2 dB or 2°
for –15 dB to –20 dB (ZVCE)	<1 dB or 6°
for –15 dB to –25 dB (ZVC)	<1 dB or 6°
at 10 kHz IF bandwidth	
for +3 dB to –10 dB	<0.2 dB or 2°
for –10 dB to –15 dB (ZVCE)	<1 dB or 6°
for –10 dB to –20 dB (ZVC)	<1 dB or 6°

Analyzers with couplers

Specifications are based on a matched DUT and refer to a nominal source power of **–20 dBm** at the test port.

20 kHz to 10 MHz

at 10 Hz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –20 dB (typ. –55 dB)	<0.2 dB or 2°
for –20 dB to –30 dB (typ. –65 dB)	<0.5 dB or 4°
for –30 dB to –45 dB (typ. –80 dB)	<1 dB or 6°

10 MHz to 4 GHz

at 10 Hz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –50 dB	<0.2 dB or 1°
for +3 dB to –40 dB	typ. <0.025 dB
for –50 dB to –60 dB	<0.5 dB or 4°
for –60 dB to –70 dB (ZVCE)	<1 dB or 6°
for –60 dB to –75 dB (ZVC)	<1 dB or 6°
at 3 kHz IF bandwidth	
for +10 dB to +3 dB	<1 dB or 6°
for +3 dB to –30 dB	<0.2 dB or 1°
for –30 dB to –40 dB	<0.5 dB or 4°
for –40 dB to –45 dB (ZVCE)	<1 dB or 6°
for –40 dB to –50 dB (ZVC)	<1 dB or 6°

[1)] <0.1 dB or <1° for 300 kHz to 1 MHz.

at 10 kHz IF bandwidth
- for +10 dB to +3 dB: <1 dB or 6°
- for +3 dB to –25 dB: <0.2 dB or 1°
- for –25 dB to –35 dB: <0.5 dB or 4°
- for –35 dB to –45 dB (ZVCE): <1 dB or 6°
- for –35 dB to –50 dB (ZVC): <1 dB or 6°

4 GHz to 8 GHz

at 10 Hz IF bandwidth
- for +10 dB to +3 dB: <1 dB or 6°
- for +3 dB to –45 dB: <0.2 dB or 2°
- for +3 dB to –40 dB: typ. <0.025 dB
- for –45 dB to –55 dB (ZVCE): <1 dB or 6°
- for –45 dB to –60 dB (ZVC): <1 dB or 6°

at 3 kHz IF bandwidth
- for +10 dB to +3 dB: <1 dB or 6°
- for +3 dB to –25 dB: <0.2 dB or 2°
- for –25 dB to –30 dB (ZVCE): <1 dB or 6°
- for –25 dB to –35 dB (ZVC): <1 dB or 6°

at 10 kHz IF bandwidth
- for +10 dB to +3 dB: <1 dB or 6°
- for +3 dB to –20 dB: <0.2 dB or 2°
- for –20 dB to –25 dB (ZVCE): <1 dB or 6°
- for –20 dB to –30 dB (ZVC): <1 dB or 6°

ZVCE and ZVC – Accuracy of reflection measurements

after system error correction (TOSM or full one-port)

It is assumed that the return loss of the match used for calibration is >40 dB (effective system data: directivity D_{eff} >40 dB, test port match S_{eff} >30 dB).

Analyzers with SWR bridges

Specifications are based on an isolating DUT and refer to a nominal source power of –10 dBm at the test port.

300 kHz to 8 GHz
- for +3 dB to –10 dB: <0.4 dB + 0.04 dB·f/GHz, <3° + 0.4°·f/GHz
- for –10 dB to –20 dB: <1 dB or 6°
- for –20 dB to –30 dB: <3 dB or 20°

Analyzers with couplers

Specifications are based on an isolating DUT and refer to a nominal source power of **–20 dBm** at the test port.

20 kHz to 8 GHz
- for +10 dB to +3 dB: <1 dB or 6°
- for +3 dB to –10 dB: <0.4 dB + 0.04 dB·f/GHz, <3° + 0.4°·f/GHz
- for –10 dB to –20 dB: <1 dB or 6°
- for –20 dB to –30 dB: <3 dB or 20°

Effective system data (above 200 kHz)

These data are valid between 20°C and 30°C, provided the instrument has reached thermal equilibrium (about 1 h after switch-on) and the temperature variation is not more than 1 degree after calibration.

ZVRE, ZVR, ZVCE, ZVC (bidirectional network analyzers)

after full two-port system error correction (TOSM)

	ZVRE, ZVR 50 Ω	75 Ω	ZVCE, ZVC 50 Ω
Directivity	>46 dB[1]	>40 dB[2]	>40 dB[2]
Source match	>40 dB[3]	>36 dB[4]	>36 dB[4]
Load match	>46 dB[1]	>40 dB[2]	>40 dB[2]
Transmission tracking	<0.04 dB	<0.06 dB	<0.06 dB
Reflection tracking	<0.04 dB	<0.06 dB	<0.06 dB

1) Return loss of match >46 dB.
2) Return loss of match >40 dB.
3) Phase deviation of open standard <1°.
4) Phase deviation of open standard <1.6°.

Output power

Power range (without options)

ZVRE, ZVR with test set 50 Ω	–25 dBm to 0 dBm
ZVRE, ZVR with test set 75 Ω	–27 dBm to –6 dBm
ZVCE, ZVC with SWR bridges	
300 kHz to 6 GHz	–25 dBm to –5 dBm
6 GHz to 8 GHz	–25 dBm to –8 dBm
ZVCE, ZVC with couplers	
20 kHz to 6 GHz	–25 dBm to 0 dBm
6 GHz to 8 GHz	–25 dBm to –3 dBm

Uncertainty (at –10 dBm)
These data are valid between 20°C and 30°C.

up to 2 MHz	<1 dB
above 2 MHz	<0.5 dB

Linearity above 40 kHz (referred to –10 dBm)
These data are valid between 20°C and 30°C.

0 dBm to –15 dBm	<0.4 dB
–15 dBm to –25 dBm (ZVR/E/L)	<0.6 dB
–15 dBm to –25 dBm (ZVC/E)	<0.8 dB

Resolution 0.1 dB

Spectral purity

Harmonics	ZVRE, ZVR	ZVCE, ZVC
At maximum source power		
40 kHz to 70 MHz	<–22 dBc	<–25 dBc
70 MHz to 400 MHz	<–25 dBc	<–25 dBc
above 400 MHz	<–30 dBc	<–25 dBc
At –10 dBm source power		
up to 600 MHz	<–35 dBc	<–35 dBc
above 600 MHz	<–40 dBc	<–35 dBc

Spurious <–40 dBc

SSB phase noise
1 Hz bandwidth, 10 kHz from carrier

up to10 MHz	<–110 dBc
10 MHz to 150 MHz	<–100 dBc
150 MHz to 1 GHz	<–90 dBc
above 1 GHz	<–90 dBc +20·log(f/GHz) (<–78 dBc at 4 GHz, <–72 dBc at 8 GHz)

Residual FM
RMS weighting from 10 Hz to 3 kHz

up to 10 MHz	<1 Hz
10 MHz to 150 MHz	<2 Hz
150 MHz to 1 GHz	<5 Hz
1 GHz to 2 GHz	<10 Hz
2 GHz to 4 GHz	<20 Hz
above 4 GHz	<40 Hz

Input level

Maximum nominal input level	**Receiver step attenuator 0 dB**	**≥30 dB**
Without options	0 dBm	–
With *Receiver Step Attenuator* option	0 dBm	+27 dBm

Damage level

Without options	+27 dBm	–
With *Receiver Step Attenuator* option	+27 dBm	+30 dBm

Damage DC current/voltage

With passive test set	
(internal DC short R_{in} <0.1 Ω)	0.5 A
With active test set	0.5 A or 30 V

RMS noise level (50 Ω, without options)
With 75 Ω models and the ZVC/E models with SWR bridges the noise level is higher by 6 dB.

Frequency range	IF bandwidth	Noise level
9 kHz to 50 kHz	1 kHz	<–75 dBm
50 kHz to 200 kHz	3 kHz	<–70 dBm
200 kHz to 20 MHz	3 kHz	<–90 dBm
20 MHz to 3 GHz	3 kHz	<–100 dBm
3 GHz to 4 GHz	3 kHz	<–90 dBm
4 GHz to 8 GHz	3 kHz	<–80 dBm

Test sets

In contrast to passive test sets, active test sets allow a direct DC bias of an (active) DUT via the inner conductor of the test ports.

Impedance	ZVRE, ZVR	50 Ω or 75 Ω
	ZVCE, ZVC	50 Ω

Match ZVRE, ZVR
(without system error correction)

Passive SWR bridges, 50 Ω	
40 kHz to 100 kHz	>10 dB
100 kHz to 100 MHz	>16 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>16 dB
Active SWR bridges, 50 Ω	
300 kHz to 1 MHz	>6 dB
1 MHz to 100 MHz	>16 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>16 dB
Passive SWR bridges, 75 Ω	
40 kHz to 100 kHz	>6 dB
100 kHz to 100 MHz	>12 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>15 dB
Active SWR bridges, 75 Ω	
300 kHz to 1 MHz	>4 dB
1 MHz to 100 MHz	>12 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>10 dB

Match ZVCE, ZVC
(without system error correction)

Passive SWR bridges, 50 Ω	
40 kHz to 10 MHz	>10 dB
10 MHz to 100 MHz	>16 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>16 dB
4 GHz to 8 GHz	>6 dB
Active SWR bridges, 50 Ω	
300 kHz to 5 MHz	>6 dB
5 MHz to 100 MHz	>16 dB
100 MHz to 3 GHz	>18 dB
3 GHz to 4 GHz	>16 dB
4 GHz to 8 GHz	>6 dB
Active couplers, 50 Ω	
20 kHz to 1 GHz	>6 dB
1 GHz to 8 GHz	>10 dB

PORT 2 (without system error correction) >18 dB

System error correction techniques

All analyzer models offer simple normalizations for reflection and transmission measurements, one-path two-port calibration and a full one-port calibration (3-term). Full two-port calibration TOSM (12-term) can be carried out with models ZVRE and ZVCE. ZVR and ZVC offer the greatest variety of modern system error correction methods. Apart from the techniques already mentioned, the following full two-port procedures are available: TOM, TRM, TRL, TNA, TOM-X (15-term). The names indicate the standards used for calibration:

T = Through
The T standard is a two-port standard which establishes a direct low-loss connection between the two test ports. A frequency-dependent attenuation can also be taken into account by the analyzer. The standard has to be well matched and may have any electrical length, which has to be exactly known (compare L standard).

O = Open
The O standard is a one-port standard. It realizes total reflection with a magnitude of one in the ideal case and a phase of approx. 0°. The phase response versus frequency must be accurately known to the analyzer (coefficients C_i). A frequency-dependent increase of the return loss can be considered by the analyzer. The electrical length of the O standard may be different from zero and must be exactly known.

S = Short
The S standard is a one-port standard. It realizes total reflection with a magnitude of one in the ideal case and a phase of approx.180° at short-circuit plane (coefficients L_i). A frequency-dependent increase of the return loss can be considered by the analyzer. The electrical length of the S standard may differ from zero and must be known. It causes a length-proportional frequency dependence of the phase.

M = Match
The M standard is a one-port standard which in the ideal case realizes a zero-reflection termination for the reference impedance (mostly 50 Ω). A sliding match is often used at high frequencies because it yields higher effective directivities than fixed loads.

R = Reflect
The R standard is a one-port standard. In contrast to the M standard it features high reflection which may assume any unknown value. It must be known however whether the reflect approaches an open or a short-circuit. Since line transformation must be expected because of the electrical length of the R standard, the electrical length has to be approximately known.

L = Line
The L standard is a two-port standard. It establishes an almost perfectly matched connection between the two test ports and defines the reference impedance. A frequency-dependent attenuation caused by the L standard can be considered by the analyzer. The L standard must have an electrical length that differs from that of the T standard, but the difference should not amount to an integer multiple of half the wavelength (singularity).

N = Network
The N standard is a two-port standard featuring symmetrical reflection which may assume any value other than zero but has to be identical at both ports. Same as with the R standard it must be known whether the reflection approaches an open or a short-circuit. Transmission of the N standard is arbitrary, need not be known and may vary arbitrarily versus frequency. In the extreme case it may even be one or zero.

A = Attenuator
The A standard is a two-port standard. It has to be well matched and may feature any unknown loss different to that of the T standard.

TOM-X (X = crosstalk) is an extension of the TOM method. It considers all possible crosstalk between the four receiver channels (full model). Since this technique does not use approximations, it is particularly effective in the elimination of crosstalk and thus in increasing the effective dynamic range of the system. This method however needs a higher effort. Alternatively, the automatic calibration procedure *AutoKal* (Rohde&Schwarz patent) is available as an option for ZVRE, ZVR, ZVCE and ZVC.

Display

Screen	26 cm colour LCD
Resolution	640 x 480 x 256
Sweep modes	frequency, power and time
Parameter formats (examples)	S parameters and derived quantities like SWR, impedance, admittance, group delay, etc, as well as nonlinear parameters (optional) like n dB compression point, SOI and TOI. Complex parameters are displayed either in a complex form or formatted to magnitude, phase, real or imaginary part
Diagrams (examples)	Cartesian: linear, simple or double logarithmic, segmented polar: linear, logarithmic or segmented Smith (any zoom), Inverted Smith, Charter
Scale (examples)	0.001 dB/to 50 dB/ 10 m°/to 200 k°/ 1 pU/to 10 kU/
MAX/MIN scale	automatically variable number of grid lines
Multichannel display	up to 4 independent display channels (CH1 to CH4)

Screen formats (examples)	overlay, dual or quad-channel split
Markers	8 normal markers or 7 delta markers for each display channel
Marker resolution	4 significant digits
Marker formatting	selectable, independent of trace formatting
Automatic marker functions	marker tracking, marker search, marker target, bandfilter functions, (Q, shape factor, etc)
Trace mathematics	all four arithmetical operations with up to three operands
Display lines	horizontal lines, circles or radial lines
Limit lines	pairs of curves formed from line segments in Cartesian diagrams, any circles in polar diagrams

Inputs/outputs (basic unit)

Probe power connector (PROBE 1 and PROBE 2)

Operating voltages	+15 V ± 0.3 V (<300 mA), –12 V ± 0.6 V (<300 mA)

EXT TRIGGER

(input for external trigger signal)	edge-triggered TTL signal
Polarity (selectable)	positive or negative
Minimum pulse width	1 µs

LEVEL (input for external level control)

Frequency range	0 Hz to 100 kHz
Voltage range	0 V to 10 V
Input impedance	>10 kΩ

EXT FREQ REF IN (input for external reference frequency)

Frequency	1 MHz to 15 MHz in 1 MHz steps
Max. permissible deviation	6×10^{-6}
Input level (V_{rms})	0.1 V to 3 V
Input impedance	1 kΩ

EXT FREQ REF OUT (output for internal reference frequency)

Frequency	10 MHz
Inaccuracy	$<4 \times 10^{-6} + 1 \times 10^{-6}$/a
Level (sine)	12 dBm ± 3 dB into 50 Ω

ANALYZER MONITOR	IBM-PC-compatible VGA connector for analyzer
PC MONITOR	IBM-PC-compatible VGA connector
MOUSE	IBM-PC-compatible PS/2 connector
KEYBOARD	IBM-PC-compatible 5-contact DIN connector
USER (input/output)	16 bits, TTL, user-programmable, 25-contact sub-D
COM 1/COM 2	IBM-PC-compatible serial interfaces RS-232-C, 9-contact sub-D
IEC BUS/IEC SYSTEM BUS	remote-control interfaces, IEEE 488, IEC-625-1, 24 contacts
LPT	IBM-PC-compatible printer interface, Centronics, 25-contact sub-D
MULTIPORT	control of optional three-port and four-port adapters
DC MEAS INPUTS	Voltage range –10 V to +10 V Measurement accuracy 0.1 V Input resistance >10 kΩ

Optional inputs/outputs (rear panel)

PORT BIAS1/2 (inputs) DC bias for PORT1/2 (for active test sets only)	<200 mA or <30 V

***Mixer Measurements* option**
EXTERNAL GENERATOR
Connectors for high-speed control of an external generator from Rohde&Schwarz families SME/SMP. The BLANK signal is low at each frequency point of the sweep and high during the transition from one point to the next. The analyzer controls the external generator by means of the TRIGGER signal. To set the generator to the next frequency point, the TRIGGER signal goes high for a brief period of time.

BLANK (input)	TTL signal
TRIGGER (output)	TTL signal

***Reference Channel Ports* option**
a1 EXT OUT and a1 EXT IN
SMA connector pair to connect an external reference mixer for measurements on frequency-converting DUTs.

Other optional interfaces
(e.g. LAN Ethernet) are available and will be specified on request.

Specifications of options

***External Measurements* option**
This option adds three additional front-panel connectors, OUTPUT a1, INPUT b1 and INPUT b2, to the basic unit (ZVRL: PORT 2 is used as INPUT b2) to provide direct access to the generator output and the two receiver inputs. Internal SWR bridges or couplers are bypassed. As a result, frequency range (with ZVRL, ZVRE and ZVR towards the lower end), output power and sensitivity of the network analyzer increase.

	ZVRE, ZVR	ZVCE, ZVC
Frequency range	10 Hz to 4 GHz	20 kHz to 8 GHz
Characteristic impedance	50 Ω	50 Ω
Output power at		
OUTPUT a1	–85 dBm to +7 dBm	–85 to +3 dBm
Power uncertainty (at –10 dBm)		
These data are valid between 20°C and 30°C.		
up to 2 MHz	<1 dB	<1 dB
above 2 MHz	<0.5 dB	<0.5 dB
Power linearity (referred to –10 dBm)		
These data are valid between 20°C and 30°C.		
+7 dBm to 0 dBm	<0.4 dB	–
0 dBm to –7 dBm	<0.4 dB	<0.4 dB
–7 dBm to –15 dBm	<0.6 dB	<0.4 dB
–15 dBm to –20 dBm	–	<0.6 dB
Parasitic DC at OUTPUT a1		
up to 10 MHz	<100 mV	
above 10 MHz	<20 mV	
Match of		
INPUT b1 and INPUT b2	>8 dB	
	Receiver step attenuator	
	0 dB	**≥30 dB**
Maximum nominal input level at INPUT b1 and INPUT b2	–3 dBm	+27 dBm
Damage level at INPUT b1 and INPUT b2	+20 dBm	+30 dBm
Max. nominal DC	5 V	
Damage DC	5 V	

RMS noise level (with step attenuators set to 0 dB)
(For models ZVCE and ZVC values are reduced by 5 dB.)

Frequency range	IF bandwidth	Noise level
10 Hz to 50 Hz (ZVRL, ZVRE, ZVR)	1 Hz	<–115 dBm
50 Hz to 500 Hz (ZVRL, ZVRE, ZVR)	10 Hz	<–105 dBm
500 Hz to 20 kHz (ZVRL, ZVRE, ZVR)	100 Hz	<–95 dBm
20 kHz to 50 kHz	1 kHz	<–85 dBm
50 kHz to 200 kHz	3 kHz	<–80 dBm
200 kHz to 20 MHz	3 kHz	<–100 dBm
20 MHz to 3 GHz	3 kHz	<–110 dBm
3 GHz to 4 GHz	3 kHz	<–100 dBm
4 GHz to 8 GHz (ZVCE, ZVC)	3 kHz	<–90 dBm

Dynamic range see table on page 10

***Generator/Receiver Step Attenuator* PORT1/2 options**
These options permit the level of the output/input signals at PORT1/2 to be attenuated in 10 dB steps between 0 dB and 70 dB.

Frequency range	same as analyzer
Attenuation	0 dB to 70 dB
Attenuation steps	10 dB
Attenuation uncertainty	<2 dB

***Power Calibration* option**
With this firmware option the analyzer power can be calibrated precisely. The source power (additional power meter e.g. NRVD, NRVS or NRV from Rohde&Schwarz required) as well as the absolute power measurement of the receiver input signals (including a1 EXT) can be calibrated.

***AutoKal* option**
The *AutoKal* module is used for automatic analyzer calibration and employs a patented calibration method. It is connected to PORT1 and PORT 2 of the network analyzer and remains connected during all calibrations and measurements. It is, therefore, an integral part of the analyzer system and its two type N jacks are used as PORT1 and PORT 2. The DUT can be connected to these ports directly or via a test cable.

Frequency range	0 Hz to 8 GHz
Impedance	50 Ω
Operating temperature range	+5°C to +40°C

***Time Domain* option**
Display and gating of measured values in the time domain and transformation back to the frequency domain.

***3-Port Adapter* option**
This option adds a third port to the two ports of the network analyzer. The option contains an electronic switch for connecting PORT1 of the analyzer alternatively to PORT1or PORT3 of the *3-Port Adapter.* PORT2 of the analyzer is directly connected to PORT2 of the option and is not switched.

Frequency range	9 kHz to 4 GHz
Impedance	50 Ω
Match[1]	
(3-Port Adapter only)	
at PORT1 and PORT3	>13 dB
at PORT2	>20 dB
Attenuation[1]	
PORT1 and PORT3	
Through-connected	<6 dB
Blocked (up to 1 MHz)	>90 dB
Blocked (above 1 MHz)	>100 dB
PORT2	<0.5 dB

***4-Port Adapter* option**
This option adds two further ports to the two ports of the network analyzer. It comes in two models (02 and 03), which provide different switching functions and are thus particularly suitable for specific 4-port DUTs.
Model 02 comprises two separate switches (SPDT). The first connects PORT1 of the analyzer alternately to PORT1 or PORT3 of the *4-Port Adapter.* The second connects PORT2 of the network analyzer alternately to PORT2 or PORT4 of the *4-Port Adapter.*
Model 03 connects PORT1 of the network analyzer directly to PORT1of the *4-Port Adapter* while PORT2 of the analyzer can be switched to one of the remaining three ports of the *4-Port Adapter.*

Frequency range	9 kHz to 4 GHz
Impedance	50 Ω
Match[1] (4-Port Adapter only)	
Model 02	>13 dB
Model 03 (up to 100 MHz)	>9 dB
Model 03 (above 100 MHz)	>13 dB
Attenuation[1]	
Through-connected	
Model 02	<6 dB
Model 03	<12 dB
Blocked (up to 1 MHz)	>90 dB
Blocked (above 1 MHz)	>100 dB

***Virtual Embedding Networks* option**
This option allows measured networks or simulated networks from a CAD program to be considered in the measurement results. Mismatched DUTs such as SAW filters can be matched virtually without any additional hardware being required. Furthermore, the effect of real embedding networks like test fixtures can be eliminated by calculation complementary to calibration procedures.

***Increased Output Power for Port 1* option**
This option increases the output power at PORT1 and OUTPUT a1. The maximum power depends on the instrument model.

Max. nominal output power	PORT1	OUTPUT a1
ZVRE, ZVR	+13 dBm	+20 dBm
ZVCE, ZVC with SWR bridges		
20 kHz to 2 GHz	+6 dBm	+13 dBm
2 GHz to 6 GHz	+4 dBm	+11 dBm
6 GHz to 8 GHz	+1 dBm	+11 dBm
ZVCE, ZVC with couplers		
20 kHz to 2 GHz	+10 dBm	+13 dBm
2 GHz to 6 GHz	+8 dBm	+11 dBm
6 GHz to 8 GHz	+5 dBm	+11 dBm

Power variation (without *Generator Step Attenuator PORT1* option)

ZVRE, ZVR	–25 dB
ZVCE, ZVC with bridges	
20 kHz to 6 GHz	–23 dB
6 GHz to 8 GHz	–20 dB
ZVCE, ZVC with couplers	
20 kHz to 6 GHz	–25 dB
6 GHz to 8 GHz	–22 dB

Power linearity
These data are valid between 20°C and 30°C.

ZVRE, ZVR (referred to +3 dBm)		
9 kHz to 40 kHz		< 1 dB
40 kHz to 4 GHz	+13 dBm to –2 dBm	< 0.4 dB
	–2 dBm to –12 dBm	< 0.6 dB
ZVCE, ZVC with bridges (referred to 0 dBm)		
20 kHz to 6 GHz	+6 dBm to –9 dBm	< 0.4 dB
	–9 dBm to –17 dBm	< 0.6 dB
6 GHz to 8 GHz	+3 dBm to –9 dBm	< 0.4 dB
	–9 dBm to –17 dBm	< 0.6 dB
ZVCE, ZVC with couplers (referred to 0 dBm)		
20 kHz to 6 GHz	+10 dBm to –5 dBm	< 0.4 dB
	–5 dBm to –15 dBm	< 0.6 dB
6 GHz to 8 GHz	+7 dBm to –5 dBm	< 0.4 dB
	–5 dBm to –15 dBm	< 0.6 dB

Power uncertainty
These data are valid between 20°C and 30°C.
(power +3 dBm with ZVRE, ZVR, 0 dBm with ZVCE, ZVC)

up to 2 MHz	< 1 dB
above 2 MHz	< 0.5 dB

Harmonics

At max. output power	
20 kHz to 40 GHz	–20 dBc
40 kHz to 70 MHz	–22 dBc
70 MHz to 2 GHz	–25 dBc
2 GHz to 4 GHz	–20 dBc
4 GHz to 8 GHz (ZVCE, ZVC)	–20 dBc

	ZVRL, ZVRE, ZVR	ZVCE, ZVC
At output power	+3 dBm	0 dBm
20 kHz to 20 MHz	–30 dBc	–30 dBc
20 MHz to 2 GHz	–35 dBc	–35 dBc
2 GHz to 4 GHz	–35 dBc	–32 dBc
4 GHz to 8 GHz (ZVCE, ZVC)		–32 dBc

Linearity for ratios (b1/a1 and b2/a1) versus source power

ZVRE, ZVR	
(referred to +3 dBm)	< 0.1 dB
ZVCE, ZVC	
(referred to 0 dBm)	< 0.3 dB

Crosstalk in reverse direction

20 kHz to 200 kHz	<–75 dB
200 kHz to 5 MHz	<–105 dB
5 MHz to 1 GHz	<–110 dB
1 GHz to 3 GHz	<–100 dB
3 GHz to 4 GHz	<–90 dB
4 GHz to 6 GHz (ZVCE, ZVC)	<–90 dB
6 GHz to 8 GHz (ZVCE, ZVC)	<–85 dB

***Mixer Measurements* option**
This option allows network analysis for frequency-converting DUTs (single and multiple conversion) and almost any kind of harmonics and spurious measurements to be performed.

***Nonlinear Measurements* option**
With this option fast measurements of the n dB compression point and of second- and third-order intermodulation products (IP2, IP3, SOI, TOI) can be carried out versus frequency.

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[1] Raw data (without system error correction).

Options

Option	Type	ZVRE	ZVR	ZVCE	ZVC
Automatic Calibration AutoKal	ZVR-B1	■	■	■	■
Time Domain	ZVR-B2	■	■	■	■
Mixer Measurements	ZVR-B4	■	■	■	■
Nonlinear Measurements	ZVR-B5	■	■	■	■
Reference Channel Ports	ZVR-B6	■	■	■	■
Power Calibration	ZVR-B7	■	■	■	■
3-Port Adapter	ZVR-B8	■	■	■*)	■*)
Virtual Embedding Networks	ZVR-K9	–	■	–	■
Increased Output Power for Port1 or Output a1	ZVR-B10	■	■	■	■
4-Port Adapter	ZVR-B14	■	■	■*)	■*)
Ethernet for Internal PC	FSE-B16	■	■	■	■
IEC/IEEE Bus Interface for Internal PC	FSE-B17	■	■	■	■
Generator Step Attenuator PORT1	ZVR-B21	■	■	■	■
Generator Step Attenuator PORT2	ZVR-B22	–	■	–	■
Receiver Step Attenuator PORT1	ZVR-B23	■	■	■	■
Receiver Step Attenuator PORT2	ZVR-B24	■	■	■	■
External Measurements	ZVR-B25	■	■	■	■
Service Kit	ZVR-Z1	■	■	■	■
■ Available *) up to 4 GHz					

Main benefits in brief

	Features	Benefits	Model/ Option
Comprehensive measurement functions	Patented automatic two-port calibration AutoKal	Saves time, prevents operating errors	ZVR-B1
	New TOM calibration method	Only three standards needed	ZVR, ZVC
	Plausibility test during calibration	Avoids calibration errors	ZVR/E
	Power calibration	Accurate source power and receiver levels	ZVR-B7
	Independent measurement of four parameters	Combined capabilities of four analyzers	■
	Segmented diagram axes	Increased measurement speed	■
	Zoom function even in Smith diagram	Improved reading accuracy	■
	High-resolution 26 cm colour display	Clear readout, effortless operation	■
	Independent computation of markers	More information at a glance	■
	Scales with min/max values	Clear curve display	■
Versatile instrument	Nonlinear measurements	n dB compression point and intercept points directly versus frequency (IP2/IP3)	
	Universal measurements on frequency-converting DUTs	Harmonics and mixer measurements	ZVR-B4
	External reference channel ports	Group-delay measurements on frequency-converting DUTs	ZVR-B4 + ZVR-B6
	Multiport measurements	Real-time adjustment of three-port and four-port devices	ZVR-B8, ZVR-B14
	Automatic determination of filter characteristics	Filter parameters set with a single keystroke	■
	User-defined aperture for group-delay measurements	Independent of test frequencies	■
	Triggered measurements (point/sweep)	For measuring pulsed signals	■
	Phase unwrap	Phase measurements beyond 360°	■
	Marker tracking function	Speeds up alignment	■
	Automatic generation of equivalent circuit	Saves conversion of results	■
Versatility for automatic test systems	Use of external generators	Convenient mixer and IP3 measurements	ZVR-B4
	External Measurements option	Flexible configuration of an external test set	ZVR-B25
	IEC/IEEE bus for internal PC	SCPI standard	■
	Networking capabilities/LAN	Networking with other measuring instruments and computers	FSE-B16
Links to the PC world	Use as a PC and measuring instrument	Measurement, remote control, evaluation and documentation in one unit	FSE-B 16 or FSE-B17
	Compatible to Super Compact™ and Touchstone™	Simple data exchange	■
	Four PC slots available	Configurable like a PC	■

■ Available with all models.