MegiQ VNA-0460e

Vector Network Analyzer

Measurement Quality

© 2016 MegiQ BV. All rights reserved.

Contents

© 2016 MegiQ BV. All rights reserved.

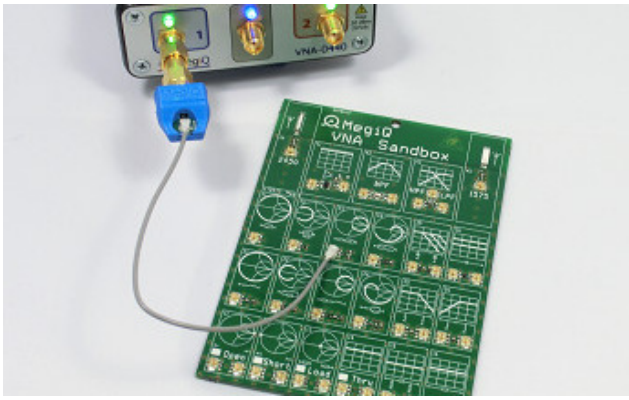
Introduction

This document describes an investigation into the quality of the measurements from the VNA-0460e. The objective was to assess the numeric results and the stability of the impedance measurements as well as to compare the quality of the graphs. To put the results into perspective, the measurements were compared the the Rohde and Schwarz ZVL6 VNA.

For the numeric and stability measurements a one-port circuit was measured during several hours without recalibration, and included a cold restart without recalibration.

For the qualitative evaluation 16 one-port and two-port circuits were measured and compared. The one-port measurements were made in pairs on the two ports, ignoring the S12 and S21 results of the two-port setup.

The measurements were done on a MegiQ VNA-Sandbox with SMA-UFL adapters and UFL-UFL cables between the adapter and the Sandbox.



The Sandbox contains a dual UFL OSLT Calkit and a number of different 1-port and 2-port circuits. Since the ZVL6 has no bias voltage/current generator the active circuits on the sandbox were not measured.

The stability measurements were done with the setup in the picture. The qualitative measurements were similar to that in the picture but with two UFL adapters and cables.

The ZVL6 data was imported into the MiQVNA software for a clear and equal presentation of the measurements. Where necessary the graphs were zoomed to show the differences.

All measurements were done from 400MHz to 6GHz and 281 points (20MHz interval). The settings of both instruments were kept at their default values except that the bandwidth of the ZVL6 was reduced to 300 Hz to get the noise on the impedance measurements down and comparable to the VNA-0460e noise. The power level was -10dBm and the input attenuators were all at 10dB.

To assess the device (in)depence of the calibration, measurements were repeated with a second VNA-0460e unit, without recalibration. The second unit was using the OSL calibration done by the first unit.

© 2016 MegiQ BV. All rights reserved.

Observations

The VNA-Sandbox measurements are quite difficult for the VNAs because of the large deviation of the UFL system from the nominal 50 Ohm impedance. This makes it harder to normalize the measurement and causes some ripples on high frequencies, in both instruments. It is especially testing for the directivity of the port detectors.

Stability

This is a summary of the stability and absolute values measured with the analyzers at two frequencies.

Stability	2040 MHz			5670 MHz		
	R	J	Z	R	J	Z
VNA-0460e #1 over 262 minutes						
Average	48,88	-0,17	48,88	0,33	-0,17	0,40
Variation (% of 50 Ohm)	**0,54%**	**1,68%**	**0,54%**	**0,38%**	**1,12%**	**0,47%**
Deviation from ZVL6	**0,40%**	**-0,32%**	**0,40%**	**0,05%**	**0,10%**	**-0,21%**
VNA-0460e #2 over 62 minutes						
Average	49,07	-0,22	49,07	0,56	-0,15	0,59
Variation (% of 50 Ohm)	**0,24%**	**0,94%**	**0,24%**	**0,28%**	**0,78%**	**0,43%**
Deviation from ZVL6	**0,78%**	**-0,42%**	**0,78%**	**0,53%**	**0,15%**	**0,17%**
ZVL6 over 177 minutes						
Average	48,68	-0,01	48,68	0,30	-0,22	0,51
Variation (% of 50 Ohm)	**0,42%**	**1,60%**	**0,42%**	**0,46%**	**3,26%**	**2,14%**

Note: VNA-0460e #2 measurements were done with the OSL calibration of unit #1.

- The stability of both analyzers is almost the same at about 0.5%, although the ZVL6 has a higher variation after a cold start.
- The OSLT calibration of the VNA-0460e is device independent. The calibration done with one unit can be used by another unit.
- The absolute values of the measurements are within 0.4% identical. After swapping a VNA-0460e they are still within 0.8% identical.

Measurement quality

- Closeups of the measurements near 50 Ohm show that the ZVL6 is noisier than the VNA-0460. The VNA-0460 has some small spikes. In general the VNA-0460e return loss is a bit smoother.
- The directivity of the VNA-0460 seems a bit higher.
- The ZVL6 gain measurement is a bit more straight.
- The dynamic range of the ZVL6 at high frequencies is higher.

Overall, the results from both instruments are in good agreement with each other.

© 2016 MegiQ BV. All rights reserved.

Stability measurements

Evaluation method

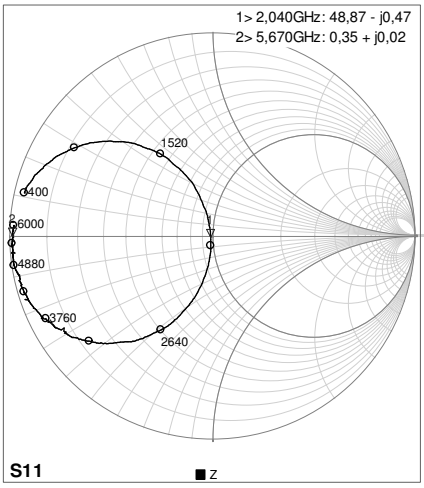
For stability testing circuit 32 of the VNA-Sandbox was used. This is a resonant circuit with 50 Ohm, 2.2nH and 2.2pF in parallel. The circuit has a parallel resonance at 2040 MHz with an impedance of nearly 50 Ohm. There is also a series resonance at 5670 MHz with a low impedance of the capacitor with its self inductance.

The instruments were calibrated in a warm state with the Sandbox UFL OSL CalKit. Both resonance impedances were monitored over a period of time. After that the instruments were turned off and cooled down and then the measurements from a cold start were monitored, starting about 2 minutes after reaching operational state. The VNA0460e reaches operational state in about 3 seconds, the ZVL6 in about 2 minutes (OS bootup). The ambient temperature was 22 C +/- 2 C. The space was not airconditioned or heated.

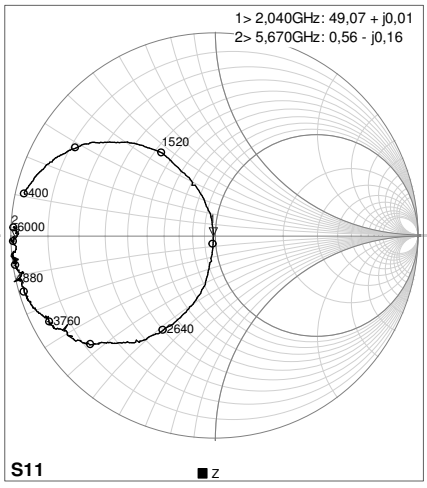
The Cold start test of the VNA-0460e was then repeated with a second VNA-0460e unit, without recalibration. The second unit was using the calibration done by the first unit.

Warm state

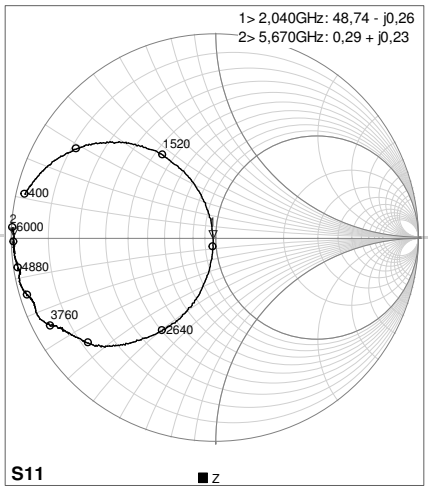
These graphs show the measurements by the three different units in warm state:



VNA-0460e #1



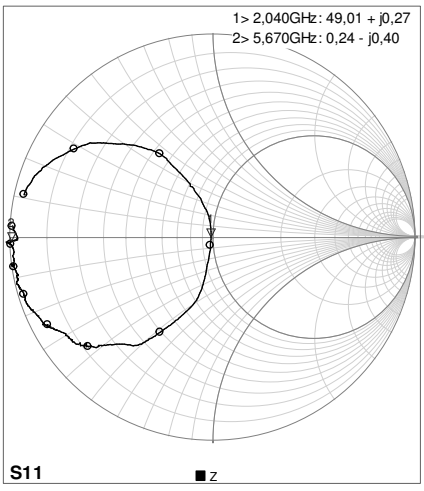
VNA-0460e #2 no recalibration



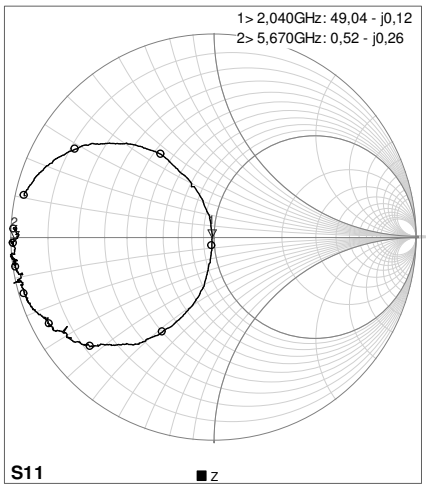
ZVL6

Cold state

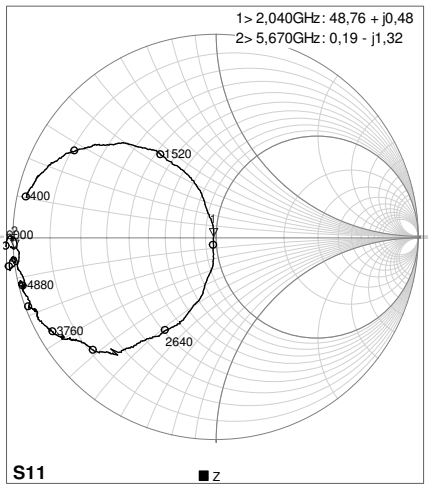
These graphs show the measurements by the three different units after about 2 minutes after bootup:



VNA-0460e #1



VNA-0460e #2 no recalibration



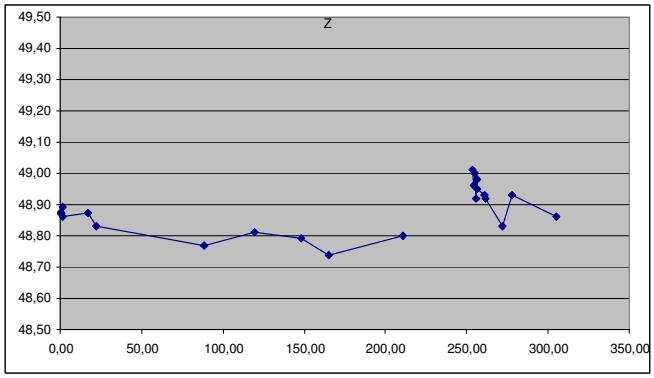
ZVL6

© 2016 MegiQ BV. All rights reserved.

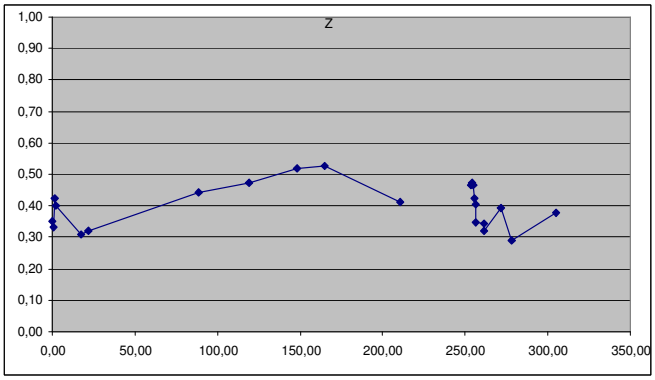
Measurements over time

Impedance (Ohm) as a function of time (minutes) at the two resonance frequencies.

VNA-0460e #1



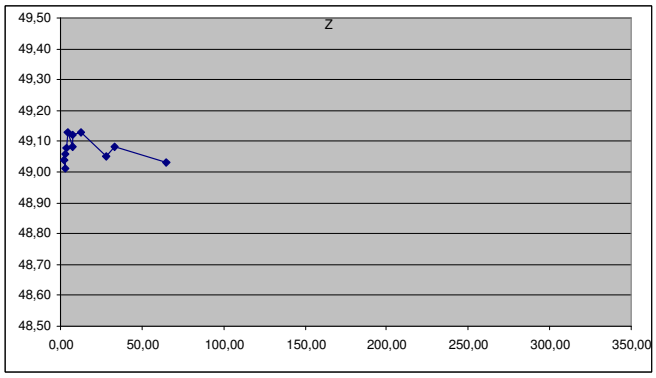
2048 MHz



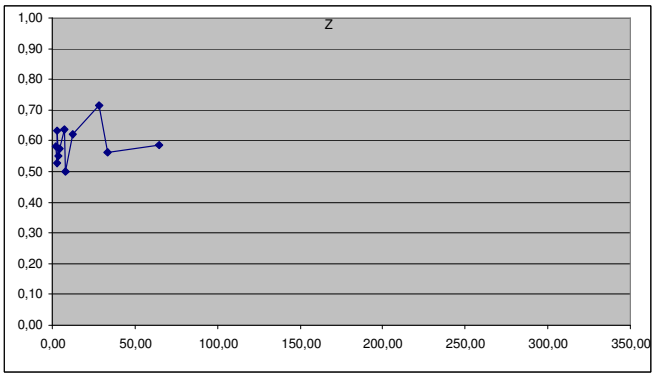
5670 MHz

Total 262 minutes. The first series was in a warm state. The second series (from 250 minutes) was after a cold start.

VNA-0460e #2



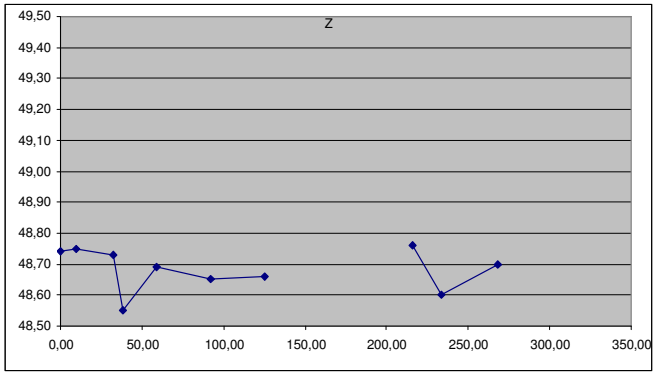
2048 MHz



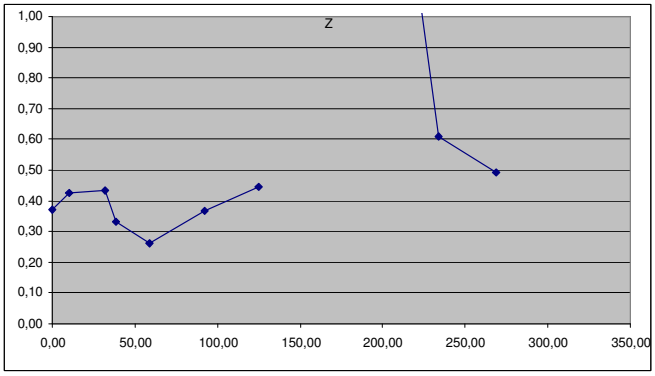
5670 MHz

Total 62 minutes. OSL Calibration was of the first VNA unit. This series was after a cold start.

ZVL6



2048 MHz



5670 MHz

Total 177 minutes. The first series was in a warm state. The second series (from 220 minutes) was after a cold start.

© 2016 MegiQ BV. All rights reserved.

Numerical results

These are the numerical results of the previous measurement sequences.

Stability	2040 MHz			5670 MHz		
	R	J	Z	R	J	Z
VNA-0460e #1 – 262 minutes						
Min	48,74	-0,57	48,74	0,22	-0,42	0,29
Max	49,01	0,27	49,01	0,41	0,14	0,53
Average	48,88	-0,17	48,88	0,33	-0,17	0,40
Variation	0,27	0,84	0,27	0,19	0,56	0,23
Variation (% of 50 Ohm)	**0,54%**	**1,68%**	**0,54%**	**0,38%**	**1,12%**	**0,47%**
Deviation from ZVL6	**0,40%**	**-0,32%**	**0,40%**	**0,05%**	**0,10%**	**-0,21%**
VNA-0460e #2 – 62 minutes						
Min	49,01	-0,51	49,01	0,49	-0,42	0,50
Max	49,13	-0,04	49,13	0,63	-0,03	0,72
Average	49,07	-0,22	49,07	0,56	-0,15	0,59
Variation	0,12	0,47	0,12	0,14	0,39	0,22
Variation (% of 50 Ohm)	**0,24%**	**0,94%**	**0,24%**	**0,28%**	**0,78%**	**0,43%**
Deviation from ZVL6	**0,78%**	**-0,42%**	**0,78%**	**0,53%**	**0,15%**	**0,17%**
ZVL6 – 177 minutes						
Min	48,55	-0,32	48,55	0,19	-1,32	0,26
Max	48,76	0,48	48,76	0,42	0,31	1,33
Average	48,68	-0,01	48,68	0,30	-0,22	0,51
Variation	0,21	0,80	0,21	0,23	1,63	1,07
Variation (% of 50 Ohm)	**0,42%**	**1,60%**	**0,42%**	**0,46%**	**3,26%**	**2,14%**

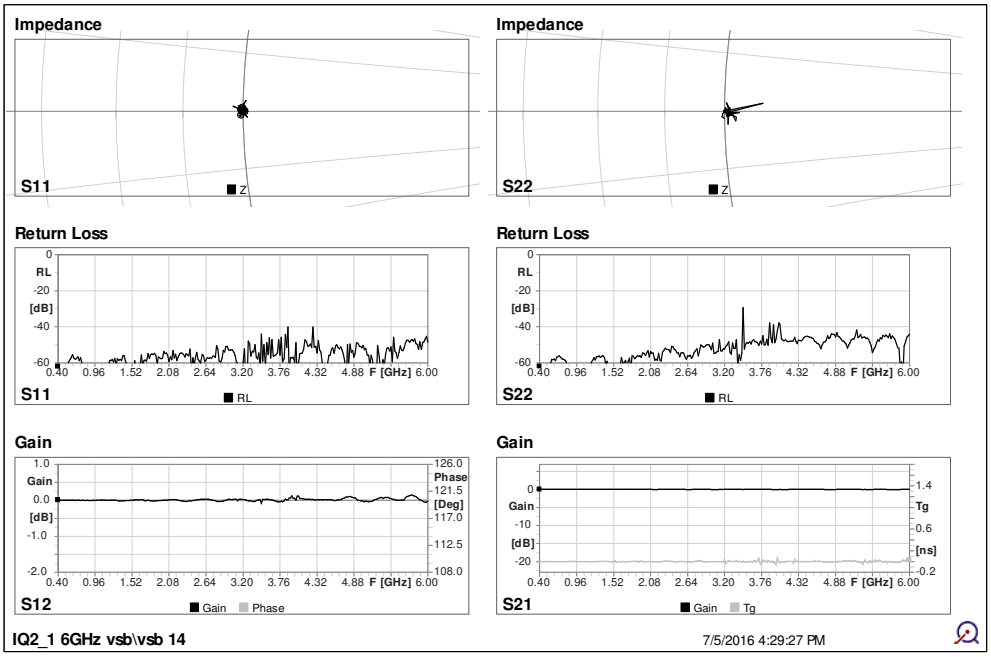
Note: VNA-0460e #2 measurements were done with the OSL calibration of unit #1.

© 2016 MegiQ BV. All rights reserved.

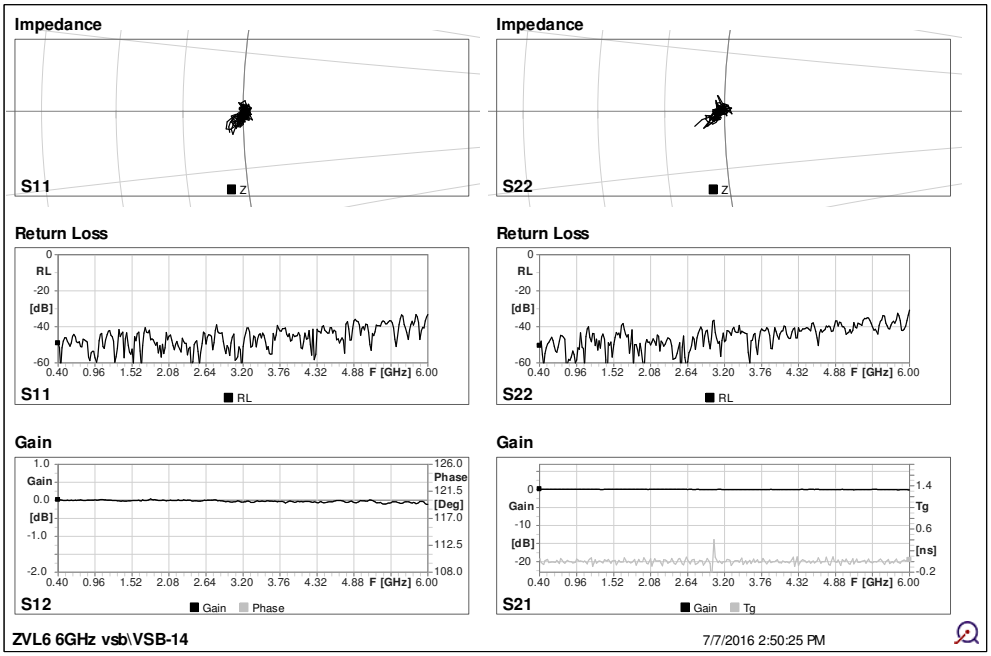
Qualitative measurements

Measurement of the VSB Through circuit immediately after finishing OSLT calibration.

VNA-0460e



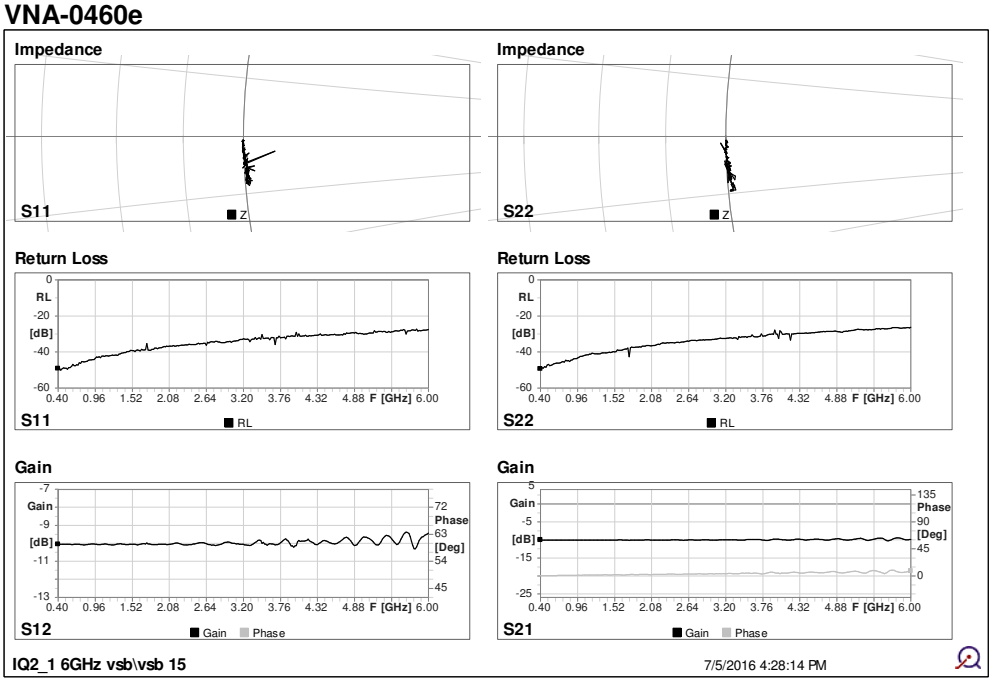
ZVL6



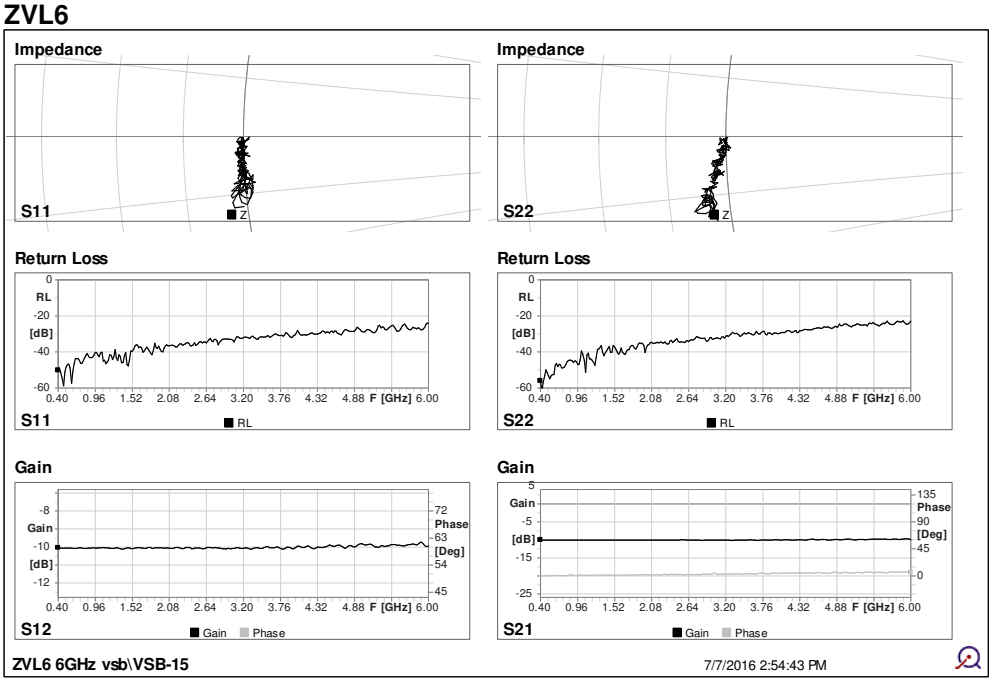
© 2016 MegiQ BV. All rights reserved.

VSB 15: 10dB Attenuator

VNA-0460e



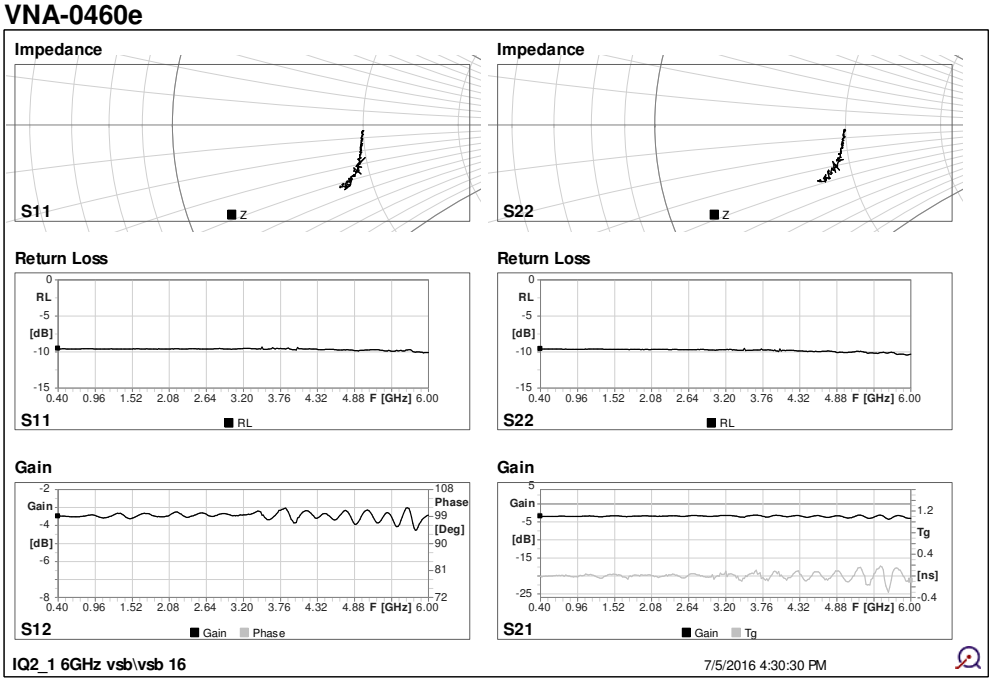
ZVL6



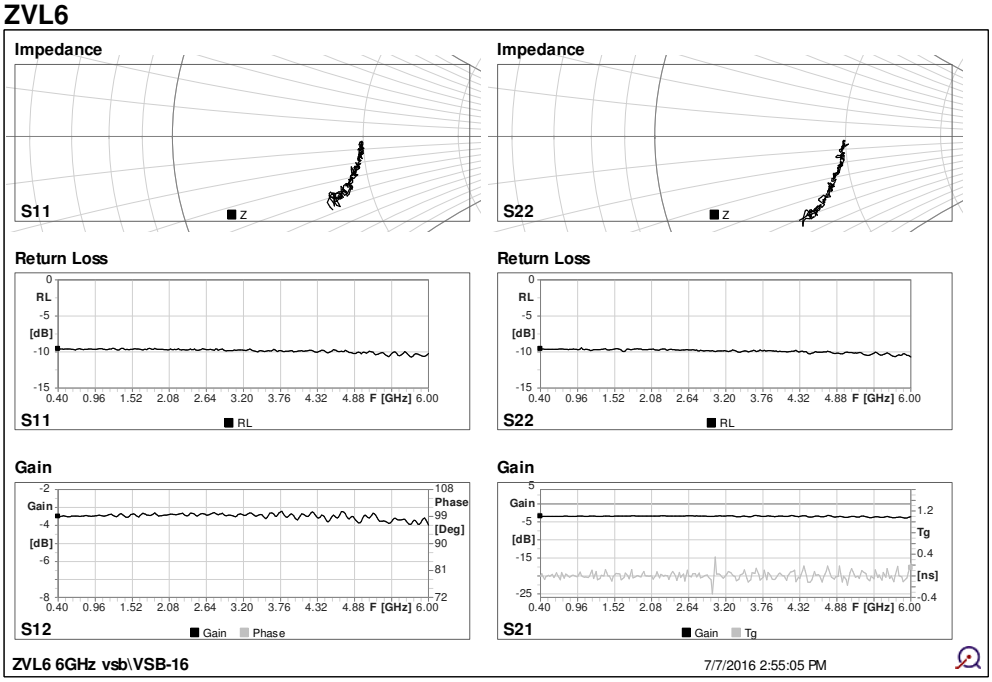
© 2016 MegiQ BV. All rights reserved.

VSB 16: 50 Ohm series resistor

VNA-0460e



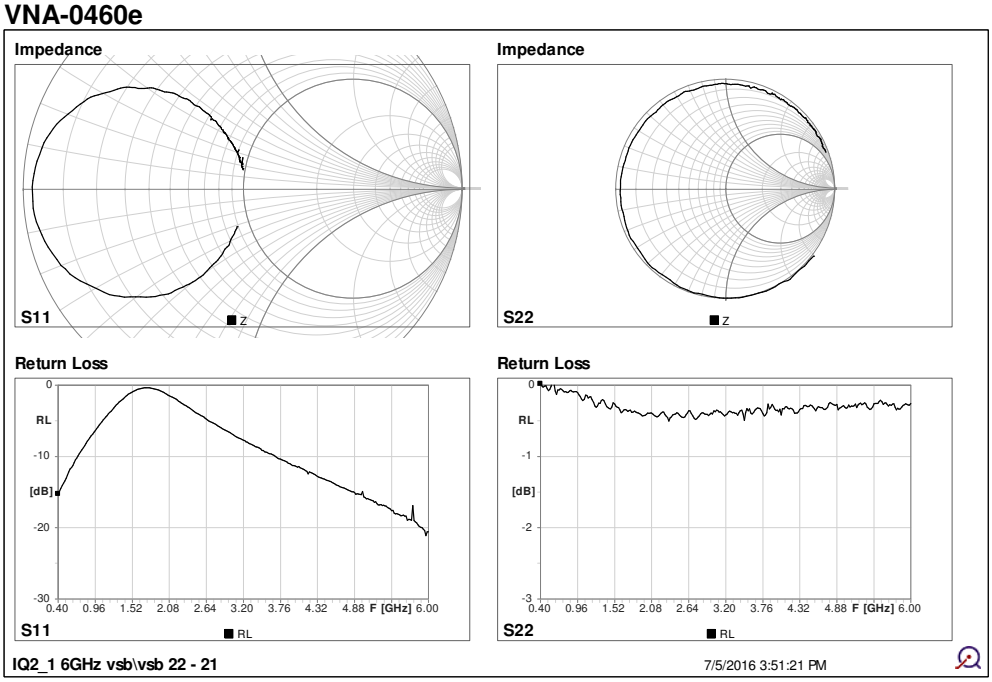
ZVL6



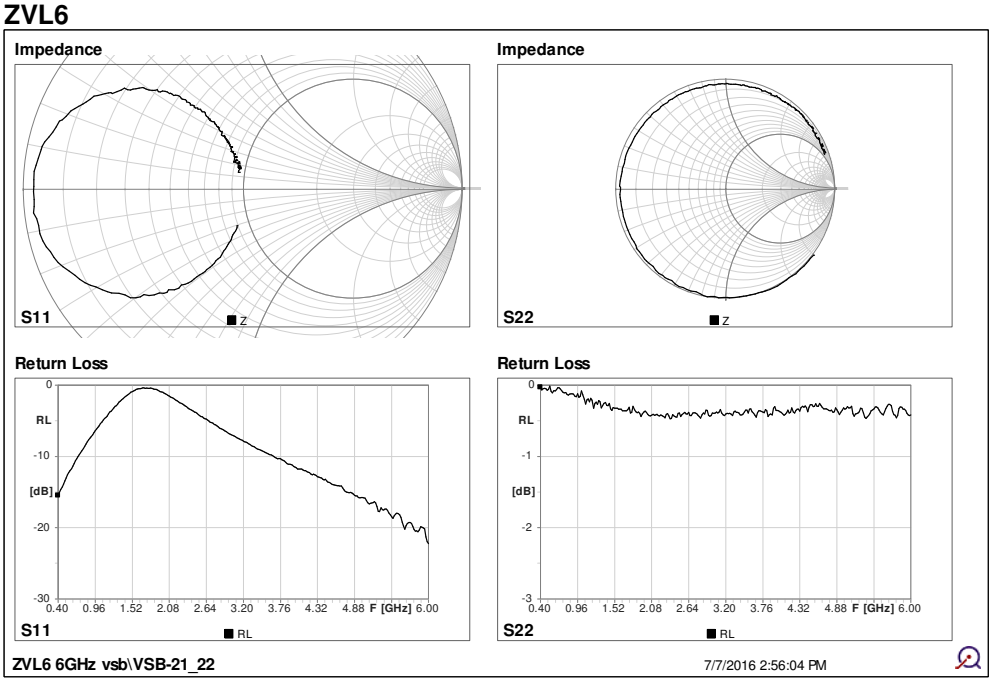
© 2016 MegiQ BV. All rights reserved.

VSB 21 / 22: Series tuned circuits

VNA-0460e



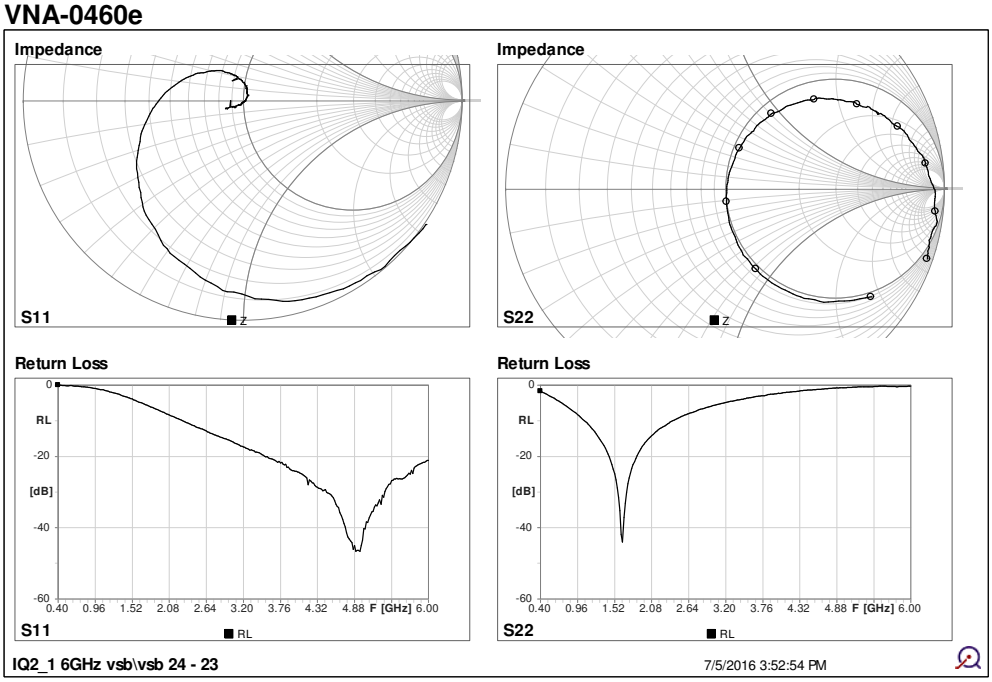
ZVL6



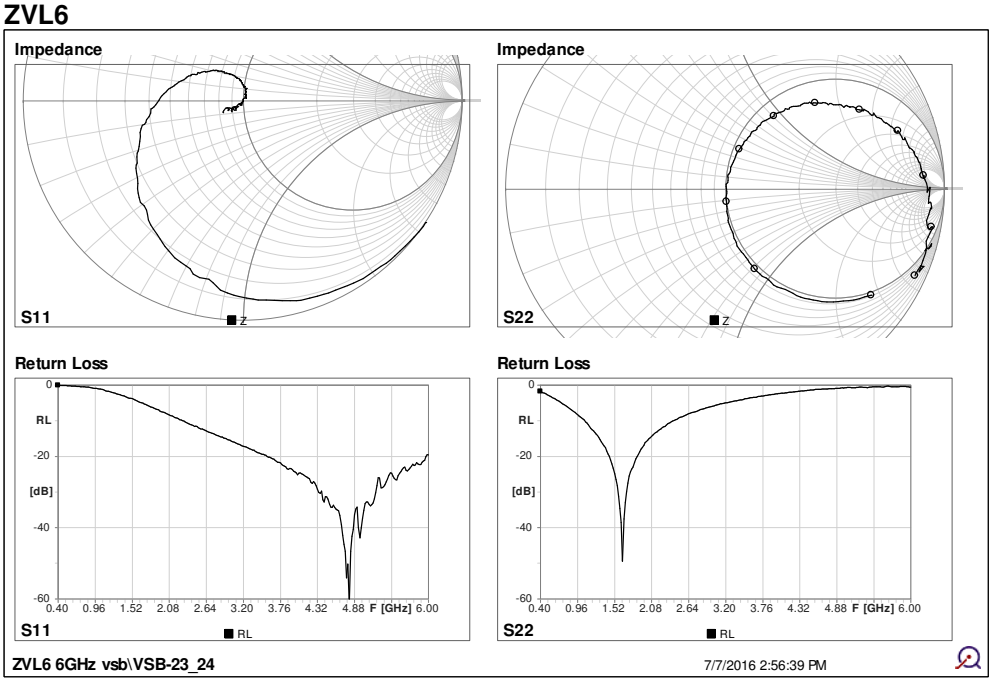
© 2016 MegiQ BV. All rights reserved.

VSB 23 / 24: Series tuned circuits

VNA-0460e



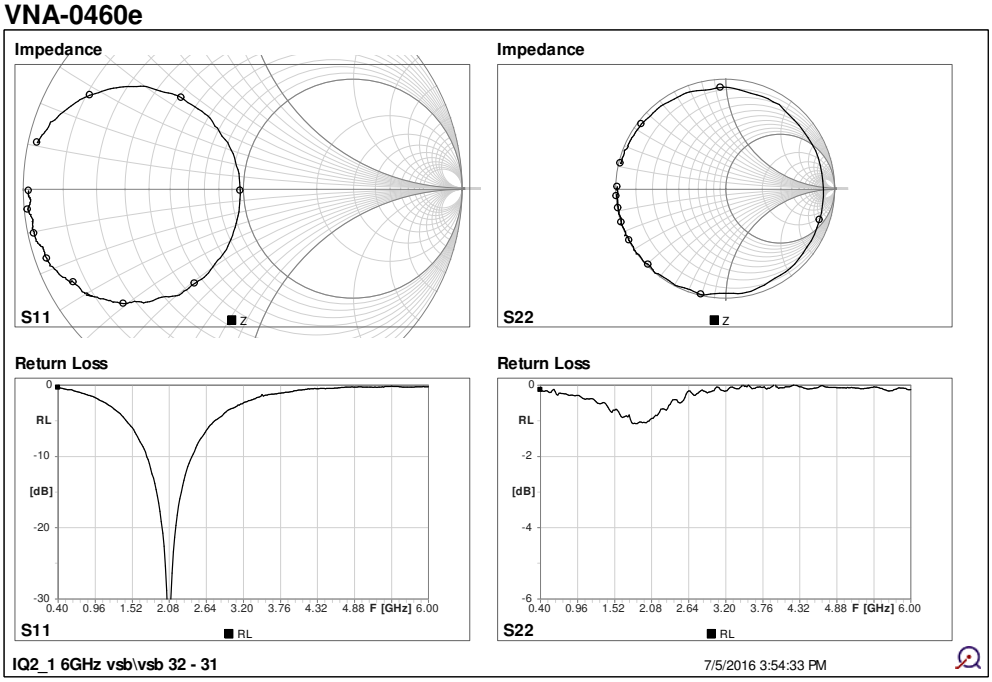
ZVL6



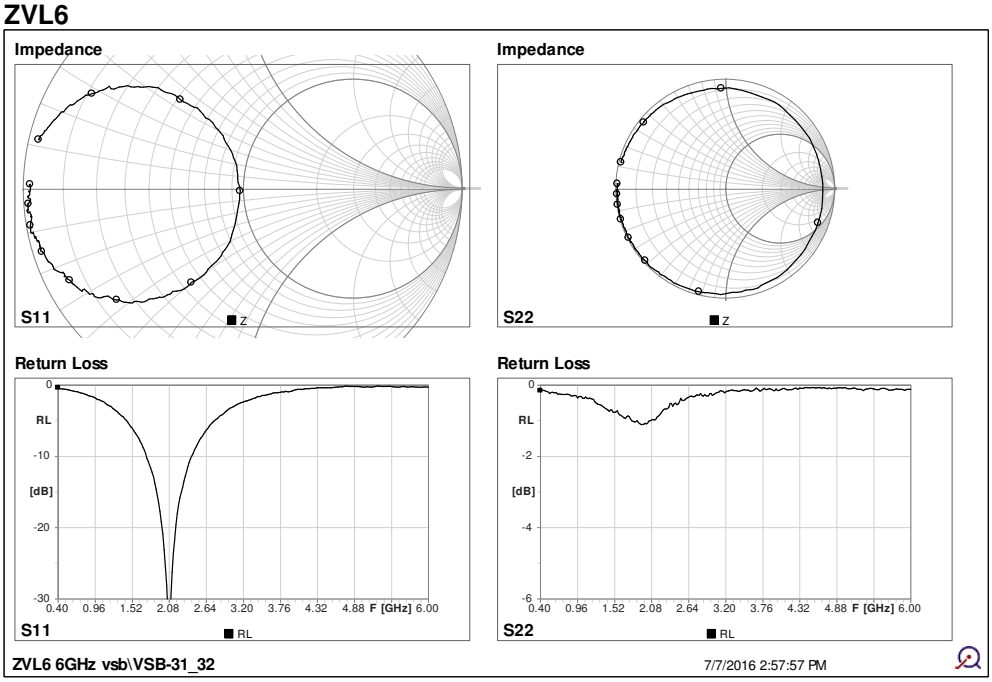
© 2016 MegiQ BV. All rights reserved.

VSB 31 / 32: Parallel tuned circuits

VNA-0460e



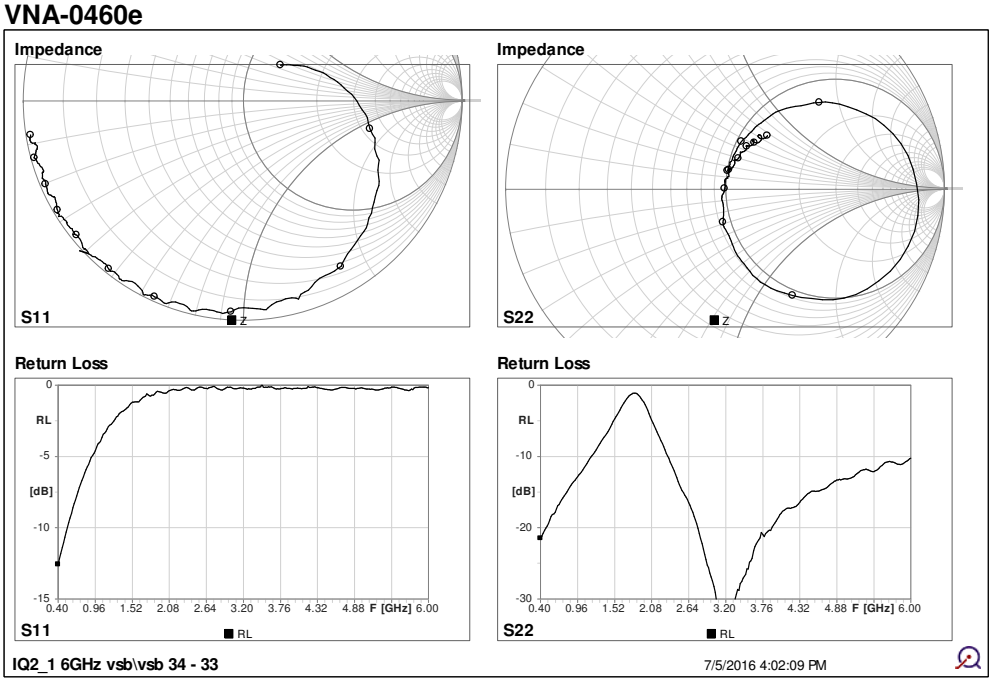
ZVL6



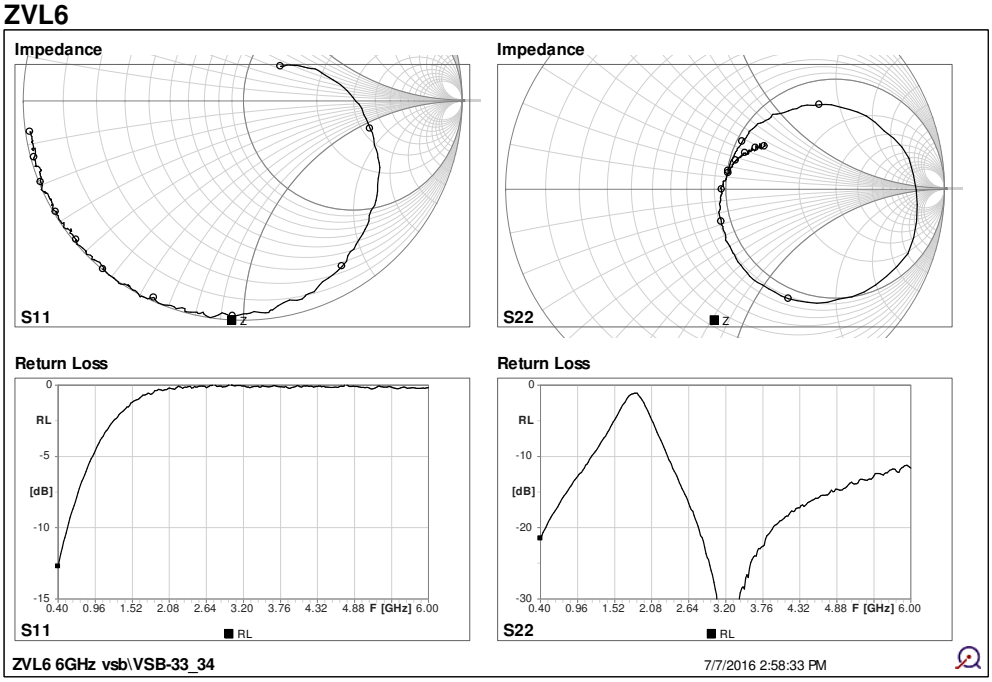
© 2016 MegiQ BV. All rights reserved.

VSB 33 / 34: Parallel tuned circuits

VNA-0460e



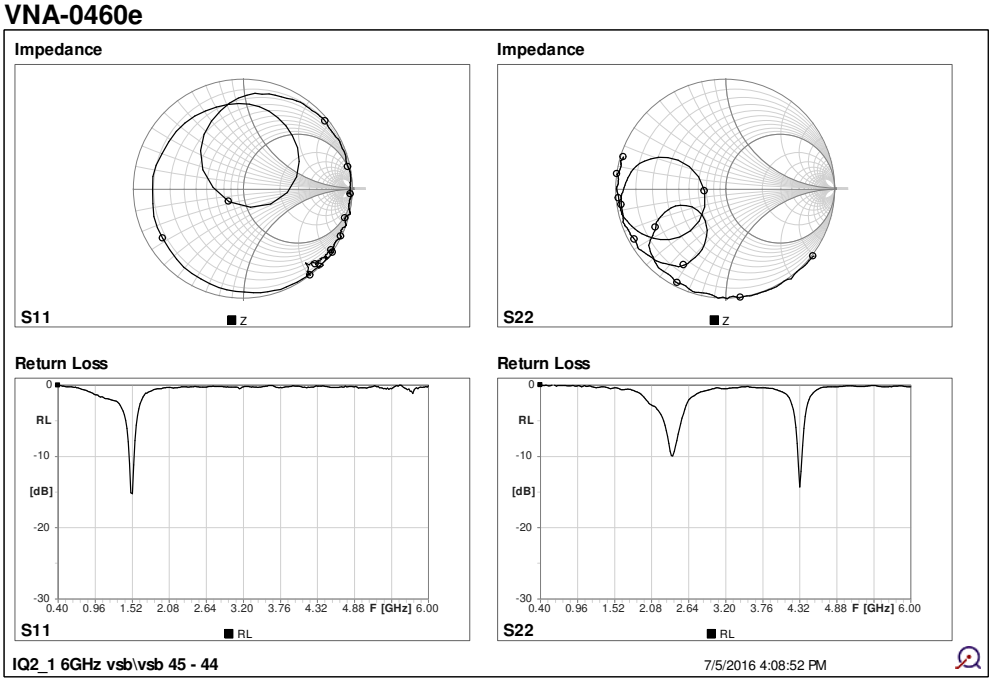
ZVL6



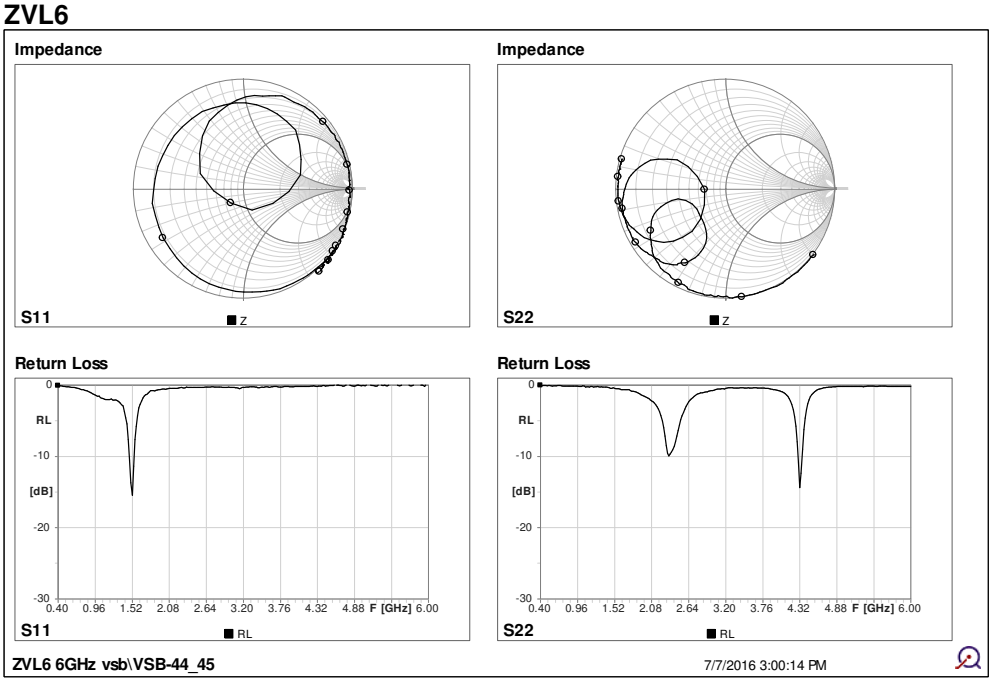
© 2016 MegiQ BV. All rights reserved.

VSB 44 / 45: GPS and Wifi antennas

VNA-0460e



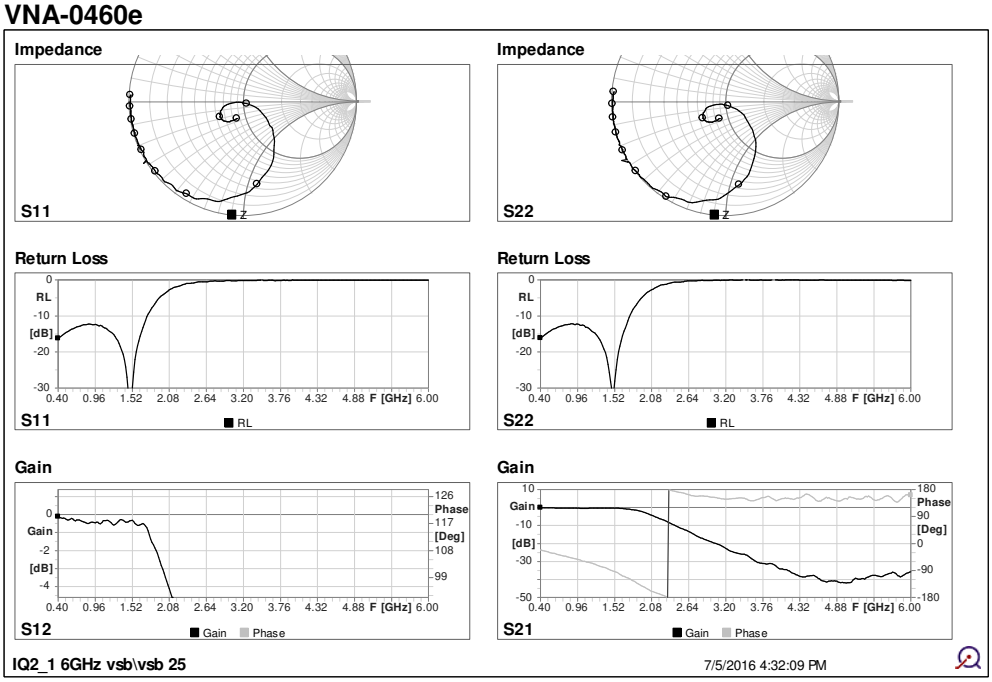
ZVL6



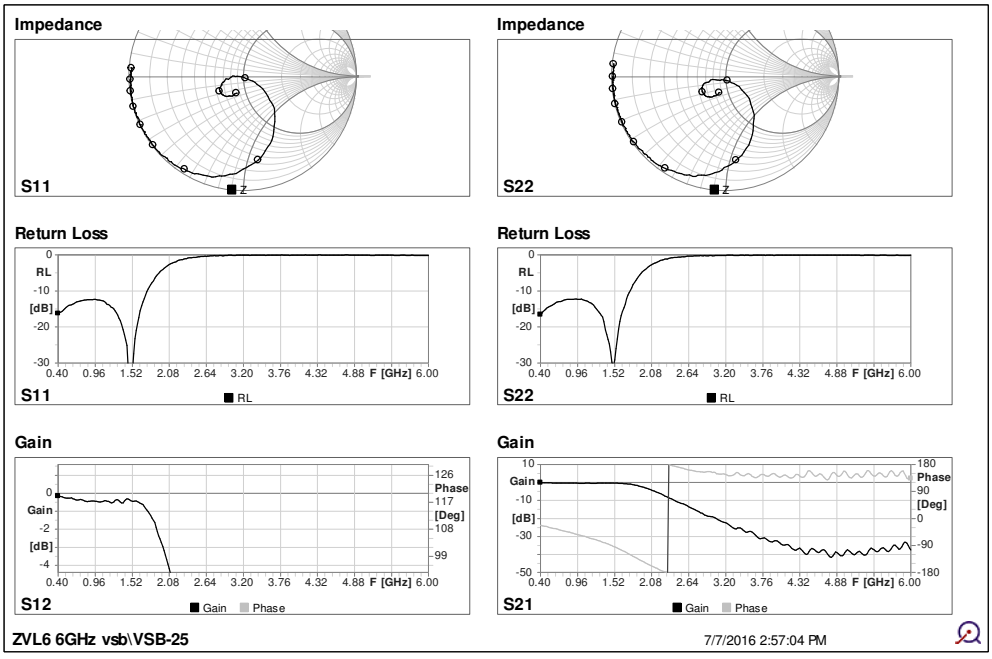
© 2016 MegiQ BV. All rights reserved.

VSB 25: Low Pass Filter

VNA-0460e



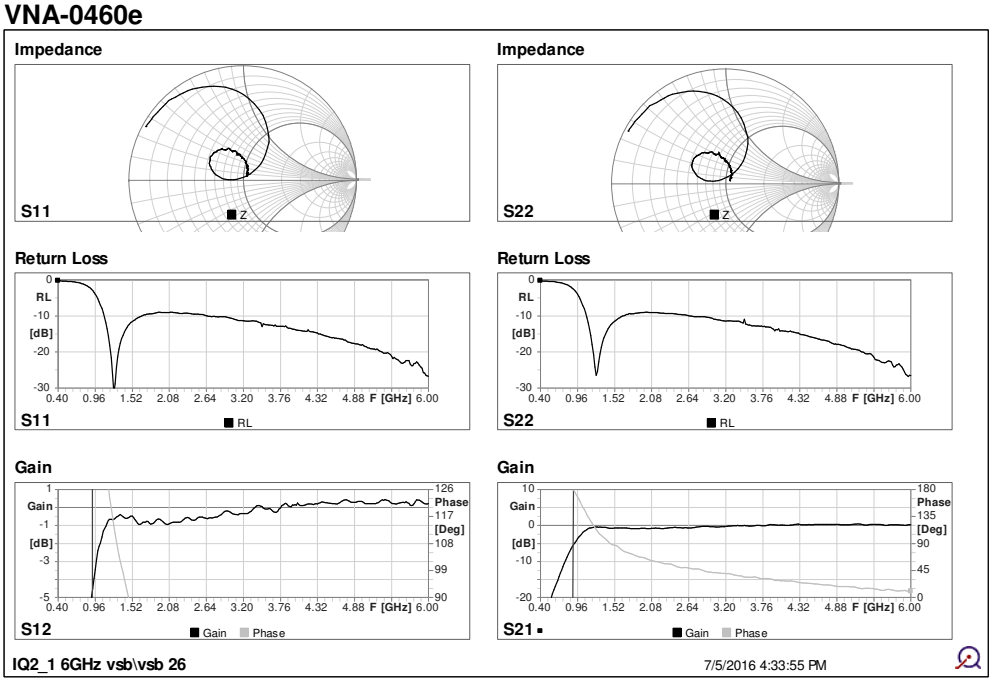
ZVL6



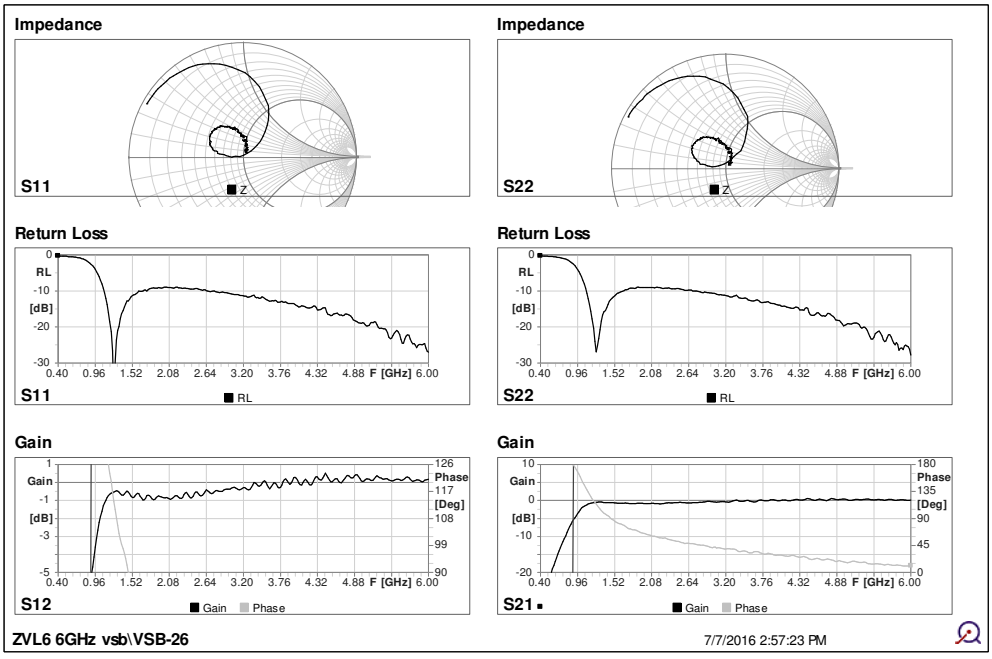
© 2016 MegiQ BV. All rights reserved.

VSB 26: High Pass Filter

VNA-0460e



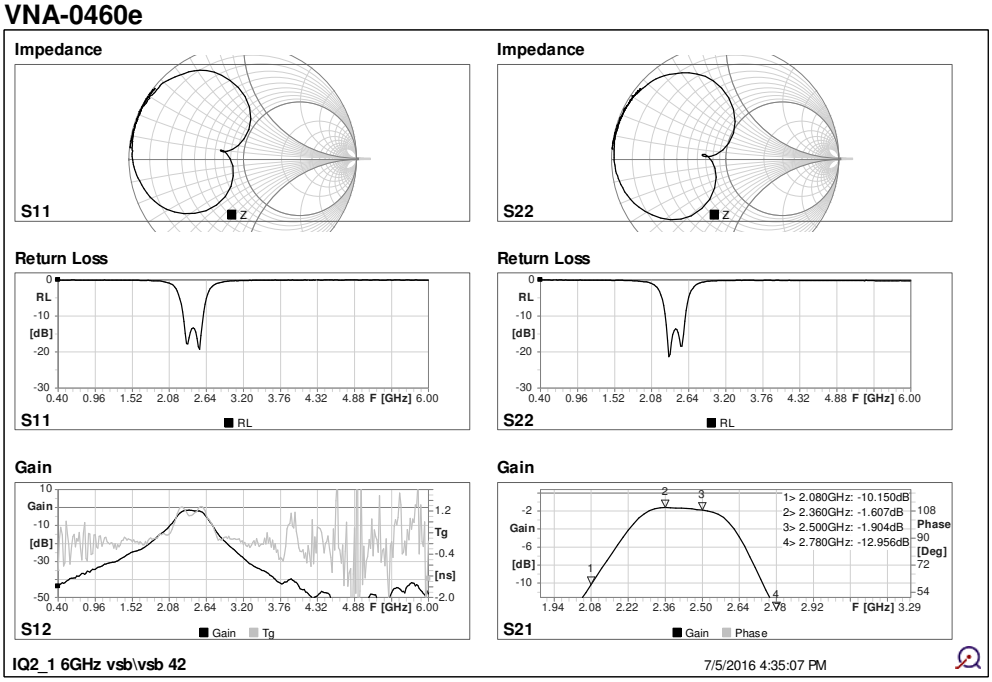
ZVL6



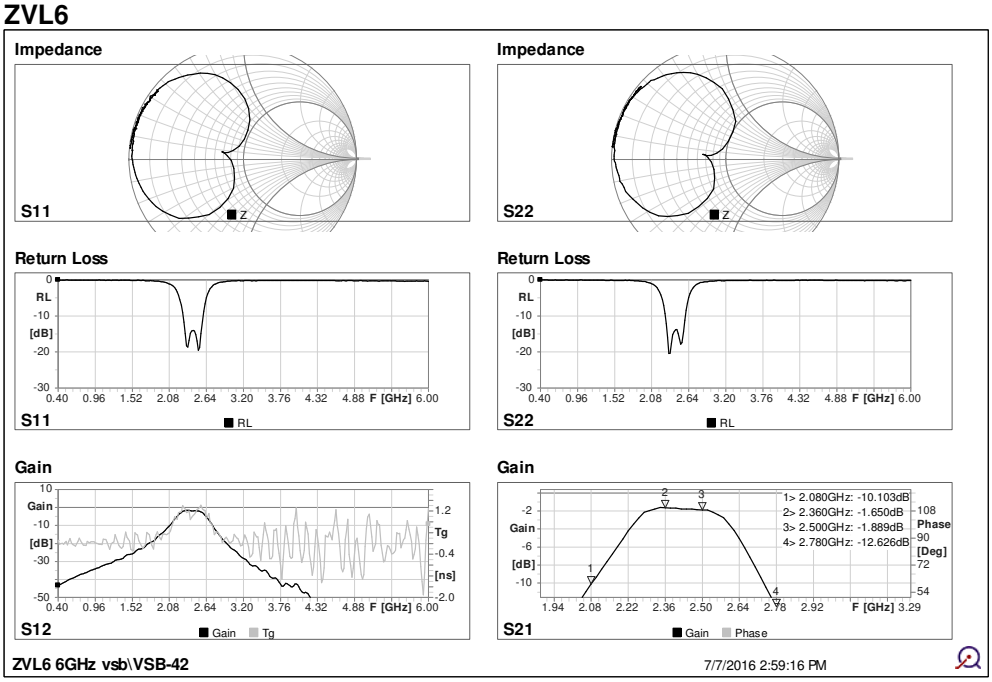
© 2016 MegiQ BV. All rights reserved.

VSB 42: Wifi Band Pass Filter

VNA-0460e



ZVL6



© 2016 MegiQ BV. All rights reserved.