



SNA-2550

Scalar Network Analyzer 400 kHz ÷ 2.5 GHz (100 kHz ÷ 2.6 GHz)



OPERATING MANUAL

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I Introduction

1. Introduction

The Scalar Network Analyzer **SNA-2550** is an instrument capable of measuring the impedance matching and the gain of circuits with a nominal impedance of 50 Ohm.

The measurement is performed by generating a sinusoidal signal, not modulated, with prescribed amplitude and frequency and measuring the input signal to the receiver with a wideband detector; this method has some limitations concerning dynamic range for low level signal (minimum detachable signal), but it has the fundamental advantage that it is easy to measure the conversion gain of circuits with input frequency different from output frequency (for example: frequency converters, frequency multipliers and dividers).

It is equipped with two BNC connectors for connecting to the device under test:

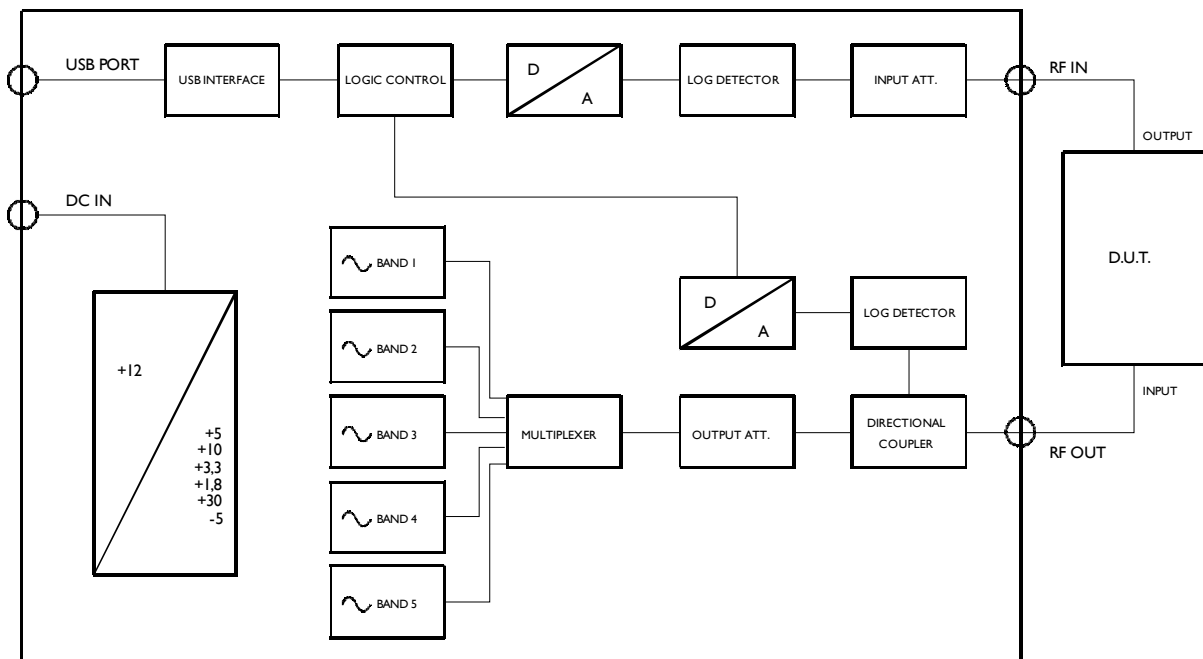
- RF OUT port (internal generator output) to be connected to the input of the device under test
- RF IN port (internal detector input) to be connected to the output of the device under test

To the RF OUT port it is also connected a bridge circuit for the measurement of the impedance matching, using a second wideband detector.

For proper operation, it needs to be controlled by a PC through a USB 2.0 port and dedicated software.

It is shipped with an external 230 VAC power supply, but it can be powered from a 12 V battery (11 – 15 VDC) at 800 mA max for mobile use.

2. Block diagram



3. Technical Specifications

Description	Values
Measurement capability	Gain – Impedance matching
Frequency range	0,4 – 2.500 MHz nominal; 0,1 – 2.600 MHz with reduced performance
Generator output level	From 0 to -50 dBm with 1 dB steps
Precision of generator output level	From 0,4 to 900 MHz: +/- 1 dB From 900 to 2500 MHz: +/- 1,5 dB (in CW mode)
Resolution of generator frequency	Less than 1 Hz (the measurement is performed on 401 equidistant points in Low Speed mode or on 101 points in High Speed mode)
Precision of generator frequency	+/- 10 ppm (+/- 0,001 %) with thermal compensation
Receiver signal full scale	From +3 to 33 dBm with 1dBm steps (signals stronger then +23 dBm only if duty cycle is less then 0,1)
Receiver signal precision	+/- 3 dB without calibration; +/- 1 dB with calibration for measurements on not frequency changing devices
Dynamic range of gain measurement	Frequencies from 0,4 to 100 MHz: from full scale to -60 dB Frequencies from 100 to 2500 MHz: from full scale to -50 dB
Dynamic range of impedance matching measurement	30 dB from 0,4 to 100 MHz; 25 db from 100 to 450 MHz 20 dB from 450 to 2000 MHz 15 dB from 2000 to 2500 MHz
Supply	11 – 15 Vdc 800 mA
Operating temperature range	5 – 35 ° C

4. Minimum PC requirements PC and operating system

- Windows 2000 o Windows XP with direct X 8.0 or later
- Personal Computer AT compatible
- Intel Pentium 4 1.8 GHz Processor or equivalent
- 128 MB RAM
- 50 MB Hard Disk free space
- 2.0 USB port
- graphic video card 1024 X 768 pixel, 65.536 (16/32 bit) colors

5. PC settings

All energy saving options should be disabled both in BIOS and operating system.

6. Installation procedure

Software installation is easy and fast. It is enough to follow the instructions founded in the “QUICK INSTALLATION GUIDE”, available in paper and also as file on the included CDROM.

2 Theoretical background

1. Theoretical background

For people not familiar with usual conventions applicable to network analyzer measurements, we revise some definitions and theoretical concepts:

A. Definition of ratio expressed in dB

- a. Voltage ratio: V_1 / V_2 (dB) = $20 \times \log (V_1 / V_2)$
- b. Power ratio: P_1 / P_2 (dB) = $10 \times \log (P_1 / P_2)$

B. Definition of gain

$$G_p = P_{out} / P_{in} \text{ (gain = output power / input power of the device under test)}$$

C. Definition of insertion loss

$$G_p = P_{in} / P_{out} \text{ (insertion loss = input power / output power of the device under test)}$$

D. Definition of voltage standing wave ratio (V.S.W.R.)

In the presence of an impedance mismatching, a bi-directional energy flux is present: from the generator to the load (feed circuit) and in the opposite direction from the load (circuit) back to the generator; in this situation, the relationship between voltage and current is not constant along the line connecting generator and load, but we can find points where voltage is high and current is low and vice versa; we define as voltage standing wave ratio (V.S.W.R.) the ratio between the maximum and the minimum voltage value present along the line; this ratio is ∞ (infinite) for a load impedance equal to zero or infinite, and is 1 for a load impedance purely resistive and equal to both the internal generator impedance (also purely resistive) and the characteristic impedance of the transmission line connecting them (perfect impedance matching condition)

E. Definition of reflection loss

In the presence of a bi-directional energy flux above described, we define as reflection loss the ratio (normally expressed in dB) between the power coming back from the load to the generator (reverse) and the power going out from the generator toward the load (forward).

F. Definition of dB μ V

Ratio in dB between the voltage to be expressed and the reference voltage of 1 μ V

G. Definition of dBm

Ratio in dB between the power to be expressed and the reference voltage of 1 mW

I. Reasons why to search for impedance matching

- **Gain maximizing**

It is possible to demonstrate mathematically that we obtain the maximum gain when the output impedance of the generator and the input impedance of the subsequent amplifier have the same real (resistive) part and opposite imaginary part (reactive); the same relation holds true also for the combination output of the amplifier and load.

- **Reduction of alterations on gain versus frequency relationship**

The correct frequency response of amplifiers and filters is strongly influenced from impedances seen by their input and output ports: impedances different from the desired ones can modify the tuning of these equipments.

- **Distortion minimization**

The amplifiers are capable to generate the maximum output power with the minimum distortion only if the load impedance is the exact value specified by the designer

- **Minimization of self – oscillations risk**

Not exact impedances can generate dangerous self – oscillations or high level of noise from amplifiers.

2. Exemplifying tables

Table with voltage ratios and power ratios displayed in dB

Voltage ratio	Correspondent dB value
0,001	- 60
0,01	- 40
0,1	- 20
0,2	- 13,98
0,3	- 10,46
0,5	- 6,02
0,7	-3,1
0,8	- 1,94
0,9	- 0,92
1	0
1,1	0,83
1,2	1,58
2	6,02
3	9,54
4	12,04
5	13,98
6	15,56
7	16,90
8	18,06
9	19,08
10	20
100	40
1000	60

Power ratio	Correspondent dB value
0,001	- 30
0,01	- 20
0,1	- 10
0,2	- 6,99
0,3	- 5,23
0,5	- 3,01
0,7	- 1,55
0,8	- 0,97
0,9	- 0,46
1	0
1,1	0,41
1,2	0,79
2	3,01
3	4,77
4	6,02
5	6,99
6	7,78
7	8,45
8	9,03
9	9,54
10	10
100	20
1000	30

Table of correspondence mV/db μ V/dBm

Voltage mV	Voltage dB μ V	Power dBm on 50 ohm
0,001	0	- 106.99
0,001122	1	- 105.99
0,00126	2	- 104.98
0,00141	3	- 104.01
0,00158	4	- 103.02
0,00178	5	- 101.98
0,00199	6	- 101.01
0,00224	7	- 99.98
0,00251	8	- 99.00
0,00281	9	- 98.02
0,00316	10	- 97.01
0,00354	11	- 96.01
0,00398	12	- 94.99
0,00446	13	- 94.00
0,00501	14	- 92.99
0,00562	15	- 91.99
0,01	20	- 86.99
0,0178	25	- 81.98
0,0316	30	- 77.01
0,0562	35	- 72.01
0,1	40	- 66.99
0,178	45	- 61.98
0,316	50	- 57.00
0,562	55	- 51.99
1,0	60	- 46.99
1,78	65	- 41.98
3,16	70	- 37.00
5,62	75	- 31.99
10,0	80	- 26.99
17,78	85	- 21.99
31,62	90	- 16.99
56,23	95	- 11.99
100,0	100	- 6.99
177,8	105	- 1.99
316,2	110	+ 3.00
562,3	115	+ 8.01
1000,0	120	+ 13.01

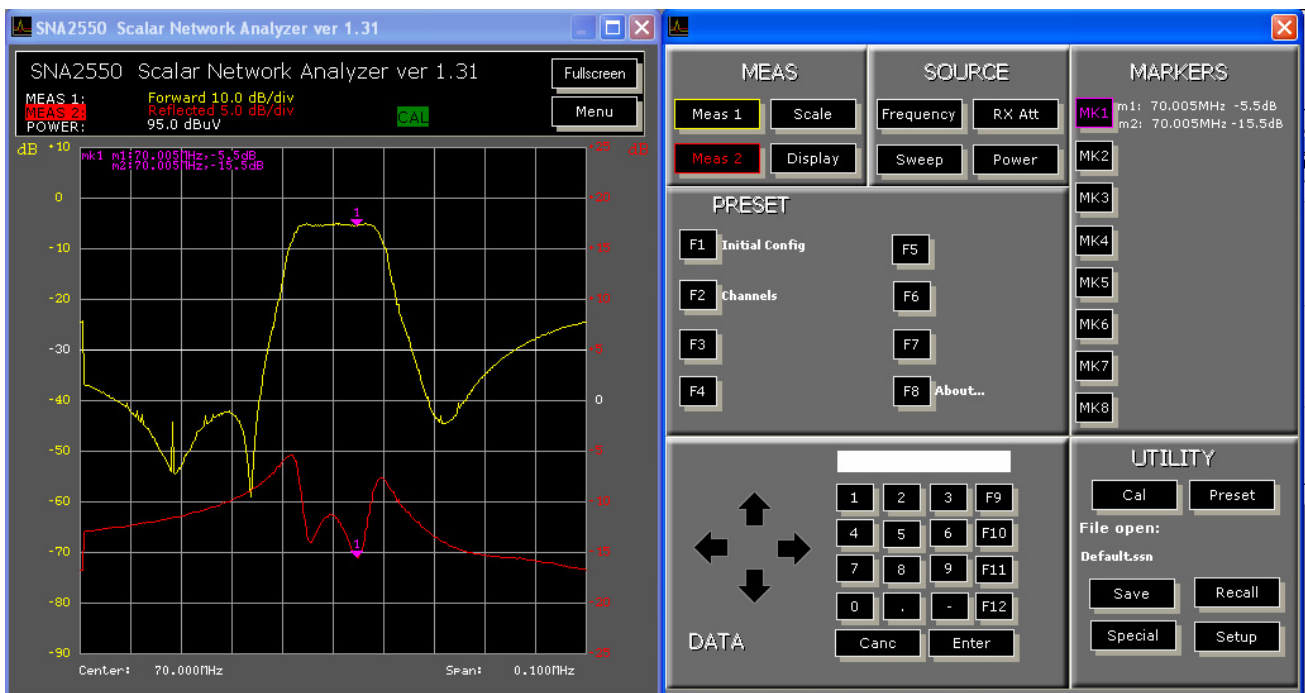
Table with relation between V.S.W.R./reflection loss/load resistance

Resistance value (ohm)	V.S.W.R.	Reflection loss (dB)	Gain loss for reflection (dB)
0.660	75,9 : 1	0,229	12,89
7	7,14 : 1	2,45	3,801
25	1,99 : 1	9,551	0,510
33	1,5 : 1	13,97	0,177
50	1,0 : 1	∞ (infinita)	0 (nulla)
67	1,34 : 1	16,75	0,089
100	1,99 : 1	9,551	0,510
400	8,00 : 1	2,180	4,037
670	13,38 : 1	1,299	5,872
6600	132,0 : 1	0,013	23,98

3 Execution of basic measurements

To execute the most common measurements, we advice to conform to the following procedure:

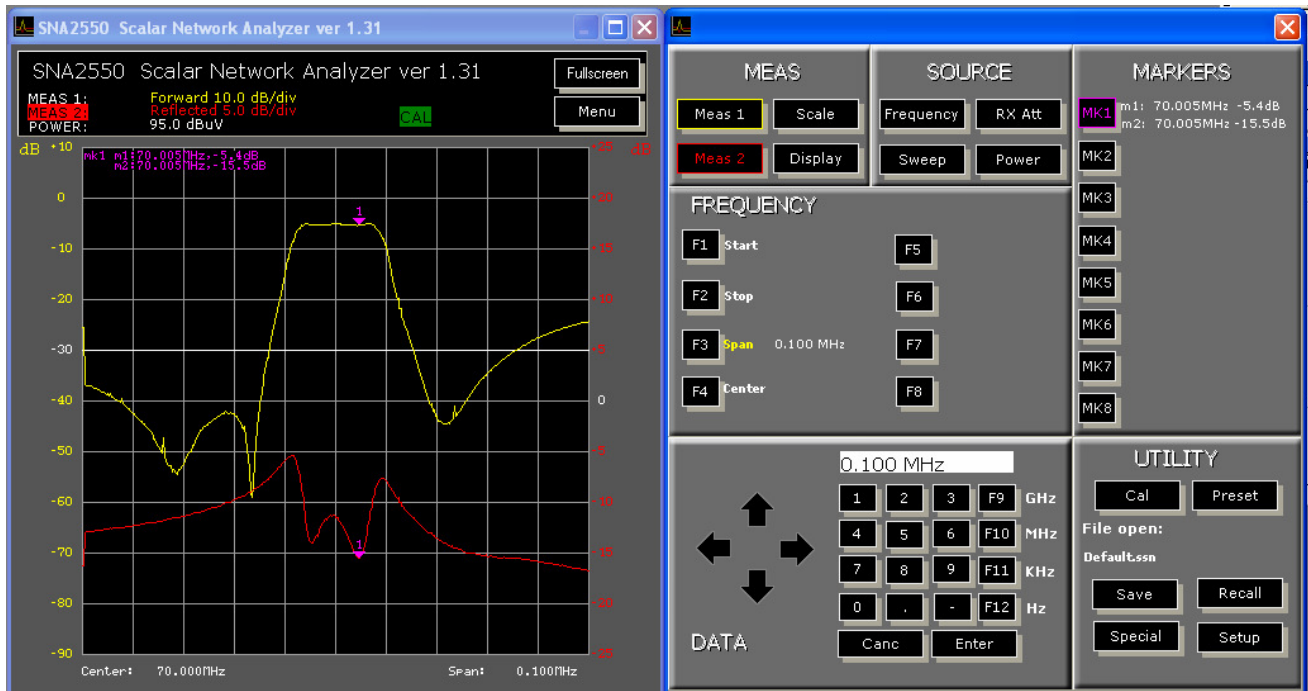
1. Measurement assignments or settings recall from “Preset”



- 1.1. Click on the pushbutton “Meas 1”; it will open the sub – menu with the buttons “**FORWARD**” (gain) e “**REFLECTED**” (reflection loss)
- 1.2. Select the wanted measurement for trace 1 (yellow one)
- 1.3. Click on the pushbutton “Meas 2”; it will open the sub – menu with the buttons “**FORWARD**” (gain) e “**REFLECTED**” (reflection loss)
- 1.4. Select the wanted measurement for trace 2 (red)

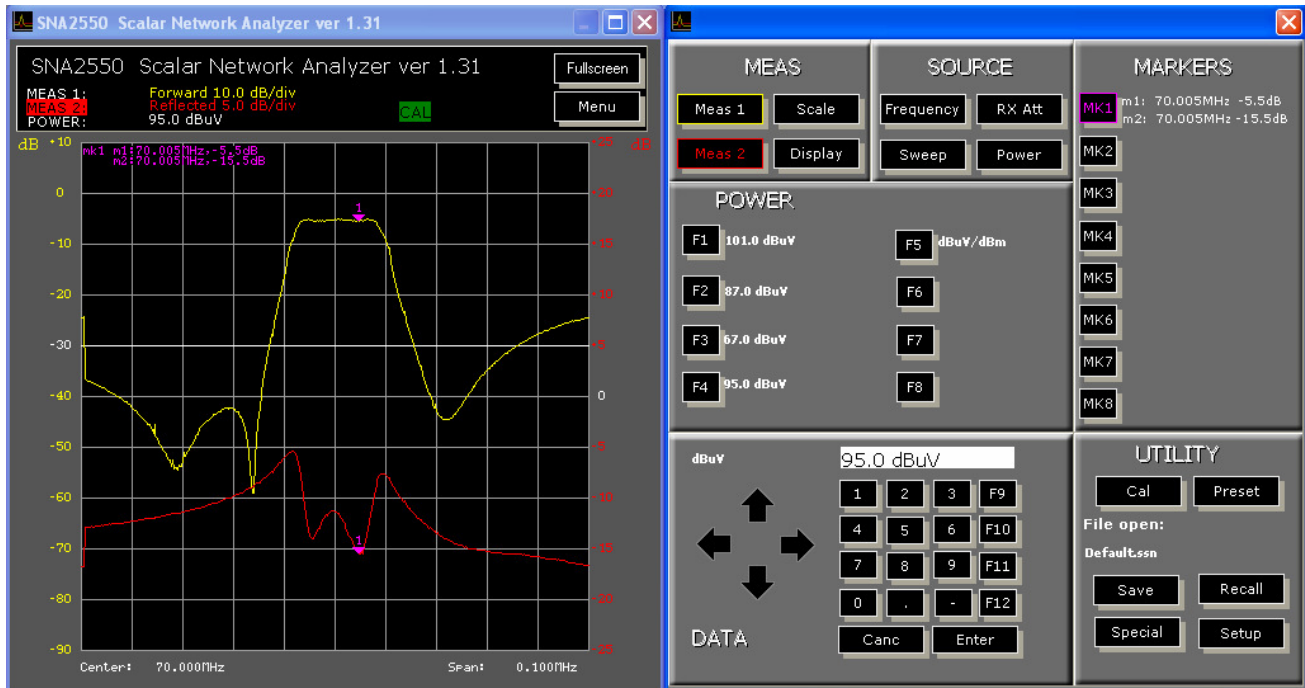
Note: Usually you will assign two different measurements to the two traces; in some circumstances, it could be useful to assign the same measurement to display simultaneously two different scales (high resolution for in band response – low resolution for out of band response)
- 1.5. As an alternative, it is possible to recall a memorized set – up clicking on the pushbutton “Preset”; it will open the sub – menu with the buttons “Initial config” and “Channels”: with the first button you will select a set – up with a full band span (from 100 kHz to 2500 MHz); with the second button you access a window that permits the selection between 50 channels according to European and Italian standards from 4 to 860 MHz.

2. Frequency setting (if you need a setting different from Preset)



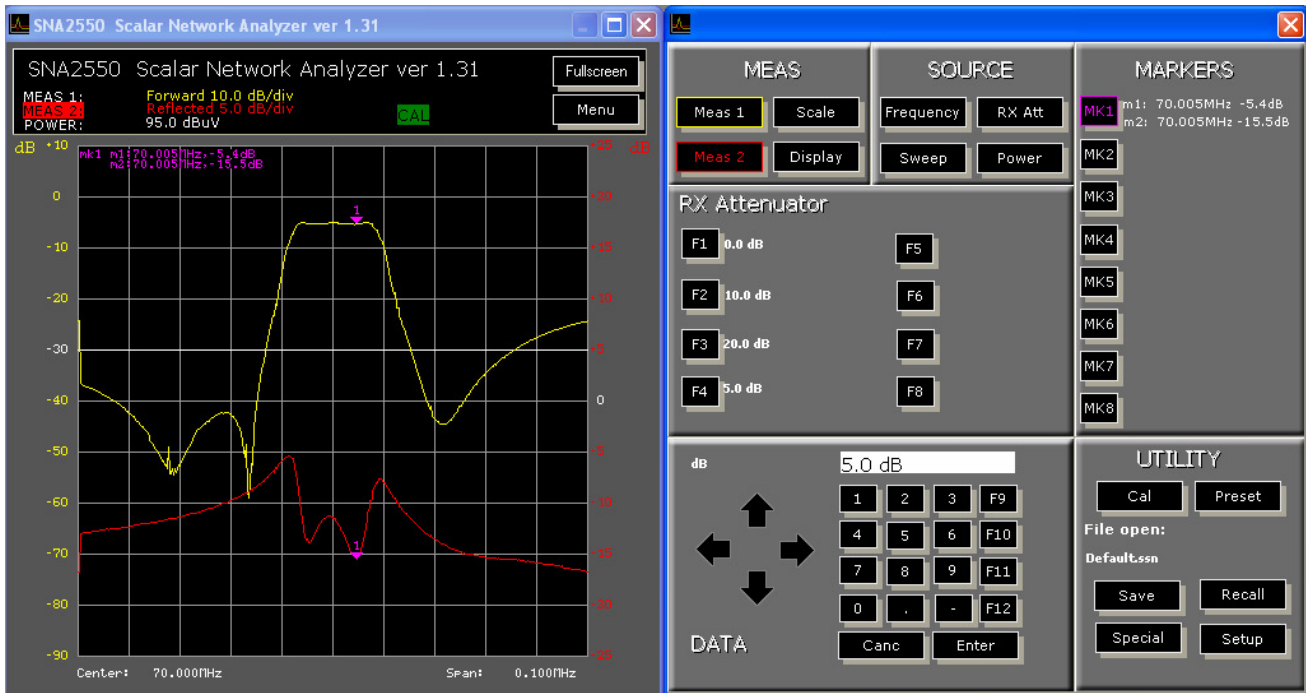
- 2.1. Click on the pushbutton "Frequency"; it will open the sub – menu with buttons "Start", "Stop", "Span" and "Center" related to the frequency interval in which you will to made the measurements
- 2.2. According to your convenience, use the two button "Start" and "Stop" or "Center" and "Span" to select the frequency interval of analysis

3. Output level setting (if you need a setting different from Preset)



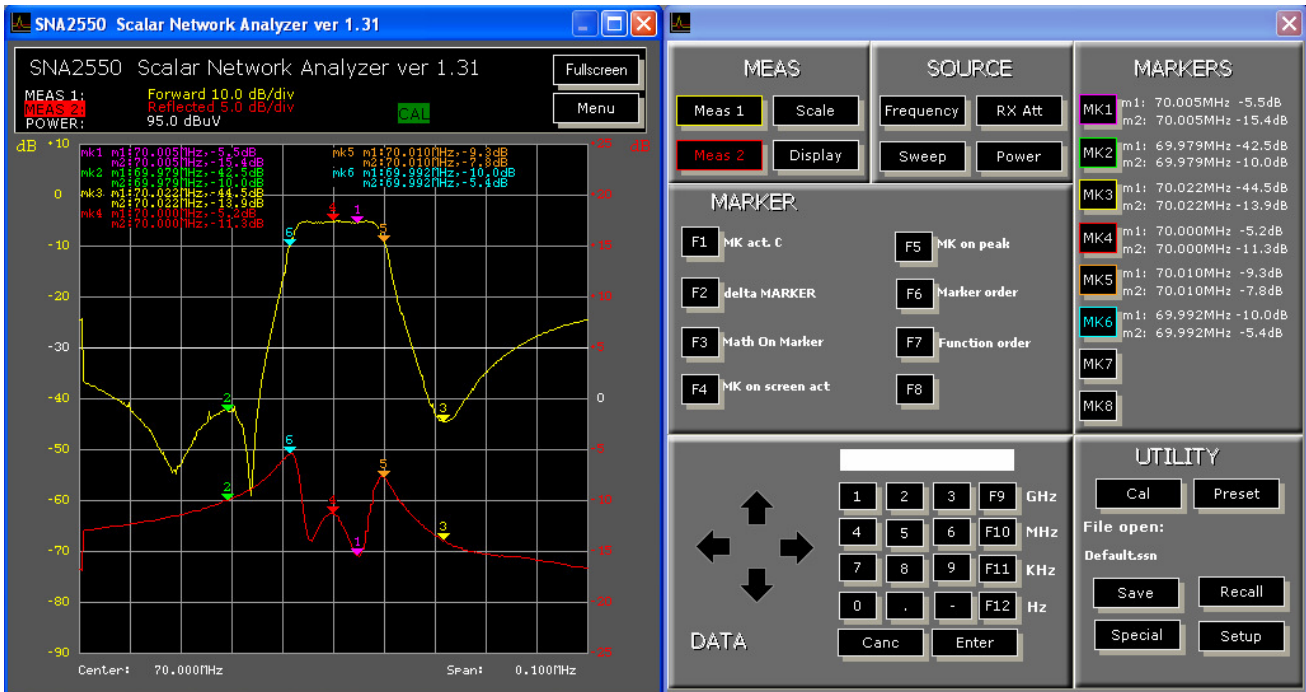
- 3.1. Click on the pushbutton “Power”: it will open the sub – menu with the buttons “100 dB μ V”, “80 dB μ V”, “60 dB μ V” e “NN dB μ V”
- 3.2. Select one of the first three buttons if you want to generate a level of 100 or 80 or 60 dB μ V; if instead you wish a different level, digit on the keyboard the value in dB μ V, click on “Enter” and then on the fourth button.
- 3.3. To choose the right test level, we give you some advices:
- 3.4. For passive devices, the maximum available level (100 dB μ V)
- 3.5. For active devices, use a level equal to: (nominal output level in dB μ V of the device under test) – (gain in dB)

4. Input attenuation setting and, as a consequence, of the full scale value for the measured signal (if you need a setting different from Preset)



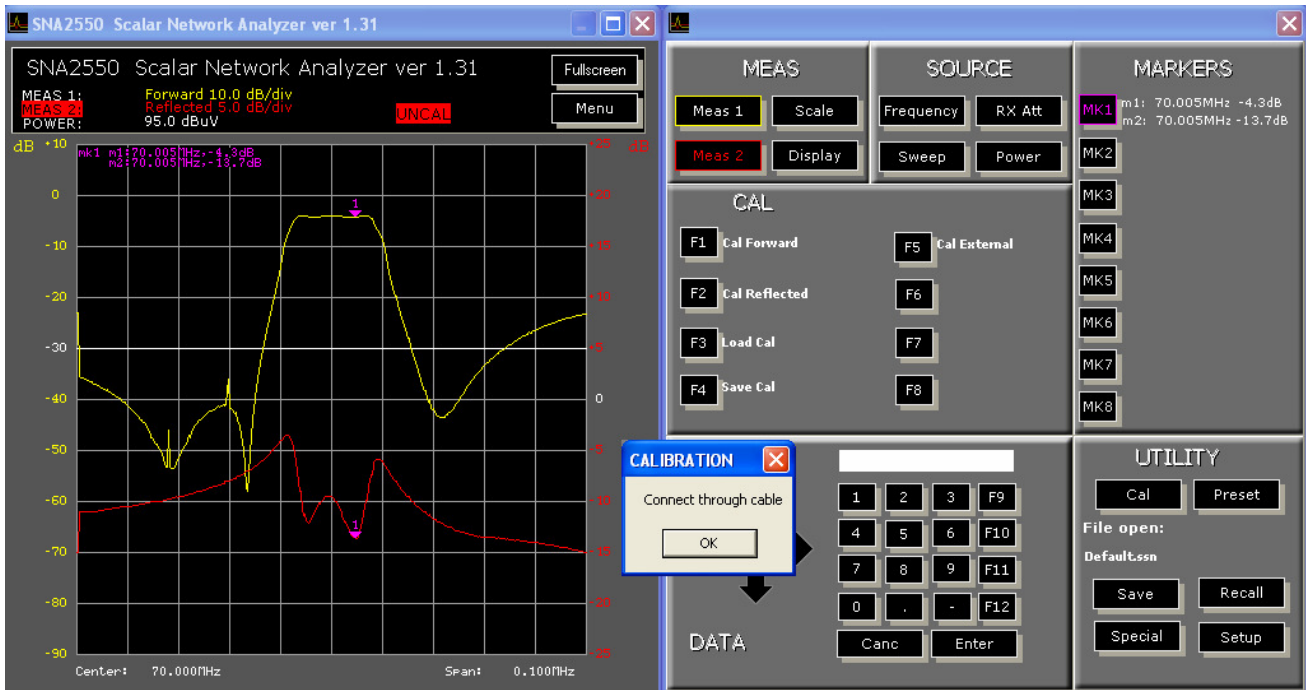
- 4.1. Click on the button “RX Att”: it will open the sub – menu with the buttons “0.0 dB”, “10.0 dB”, “20 dB” and “NN dB”
- 4.2. Select one of the first three button if you wish a full scale level of 110, 120 or 130 dB μ V respectively for 0, 10 or 20 dB of input attenuation; if instead you wish a different level, digit with the keyboard the desired value of attenuation, then click on “Enter” and on the fourth button (max 31 dB)
- 4.3. To determine the correct input attenuation value, we give you some advices:
- 4.4. For passive devices, use the minimum value, (0.0 dB)
- 4.5. For active devices, use a level equal to: (nominal output level in dB μ V of the device under test) – (110 dB μ V)

5. Marker settings (if you need a setting different from Preset)



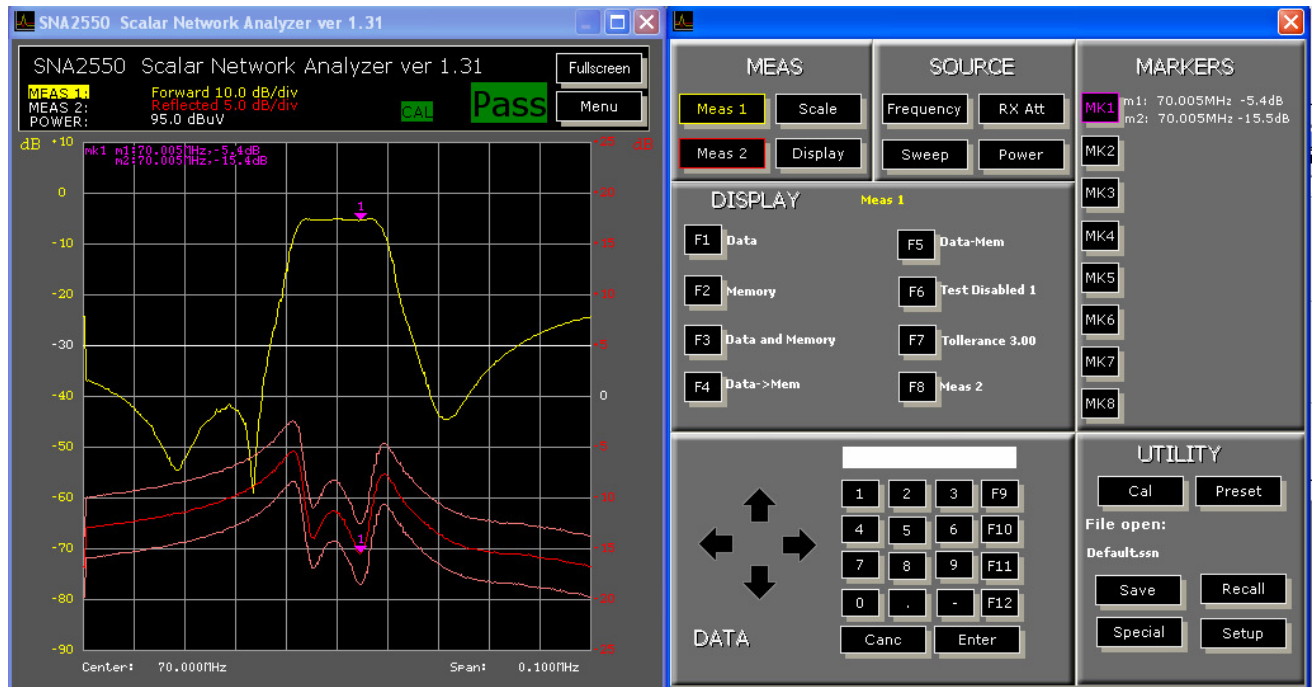
- 5.1. Selection from the keyboard: click on the button of the marker you wish to modify (the selected marker has the inscription colored and not white):
- 5.2. Digit the frequency at which you want to set the marker; the marker will go to this frequency with a little approximation
- 5.3. Quick movement: click on one of the traces to the point where you want to position the active marker: the marker will shift to the chosen point
- 5.4. To set another marker, make it active clicking on the corresponding button, then follow the procedure above described
- 5.5. To cancel a marker from the screen, click in the corresponding button one (if active) or times

6. Calibration



- 6.1. Click on the button “Cal”: it will open a sub – menu with the buttons “Cal Forward” (gain measurement calibration) and “Cal Reflected” (reflection loss calibration)
- 6.2. Connect the trough calibration cable between the two ports of the instrument; click on the button “Cal Forward”: it will open a window with the warning “Connect through cable”; click on “OK”: after a few seconds, the trace of the FORWARD measurement will superimpose on the 0 dB line
- 6.3. Disconnect the calibration cable; connect the shorted connector (Short) to the port RF OUT; click on the button “Cal Reflected”: it will open a window with the warning “Connect short to RF out port”; click on “OK”: after a few seconds, the trace of the REFLECTED measurement will superimpose on the 0 dB line
- 6.4. Connect the device under test to the ports of the instrument: device input to the port RF OUT, device output to the port RF IN.

7. PASS/FAIL test

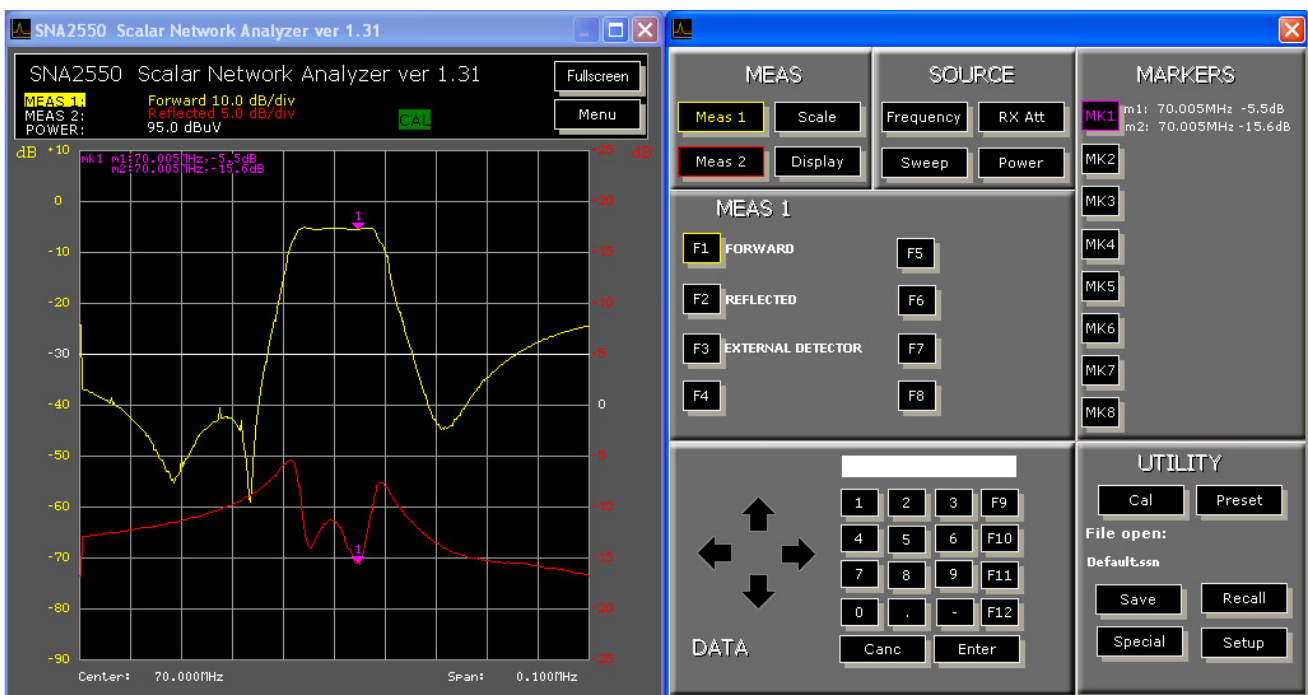


- 7.1. Click on Data ->Mem (F4) to memorize the displayed data. This will be considered as test reference data.
- 7.2. To set the desired tolerance, click on "Tolerance" (F7) and insert the value from the numeric keypad (e.g. a value of 5 dB equal to a total span of 10 dB, +/- 5 dB).
- 7.3. The key "Meas" (F8) allows to enable the test on the two measures (forward or reverse). It is possible to enable the test on both measures at the same time.
- 7.4. The key "Test Enabled/Disabled" (F6) allows to enable the test on the selected measure. Use this key to display the PASS/FAIL test area, calculated on the pre-memorized measure (see 7.1). The test result will be displayed in the upper part of the graphic by means of two labels Pass Fail.

4 Measurements personalizing & Menu

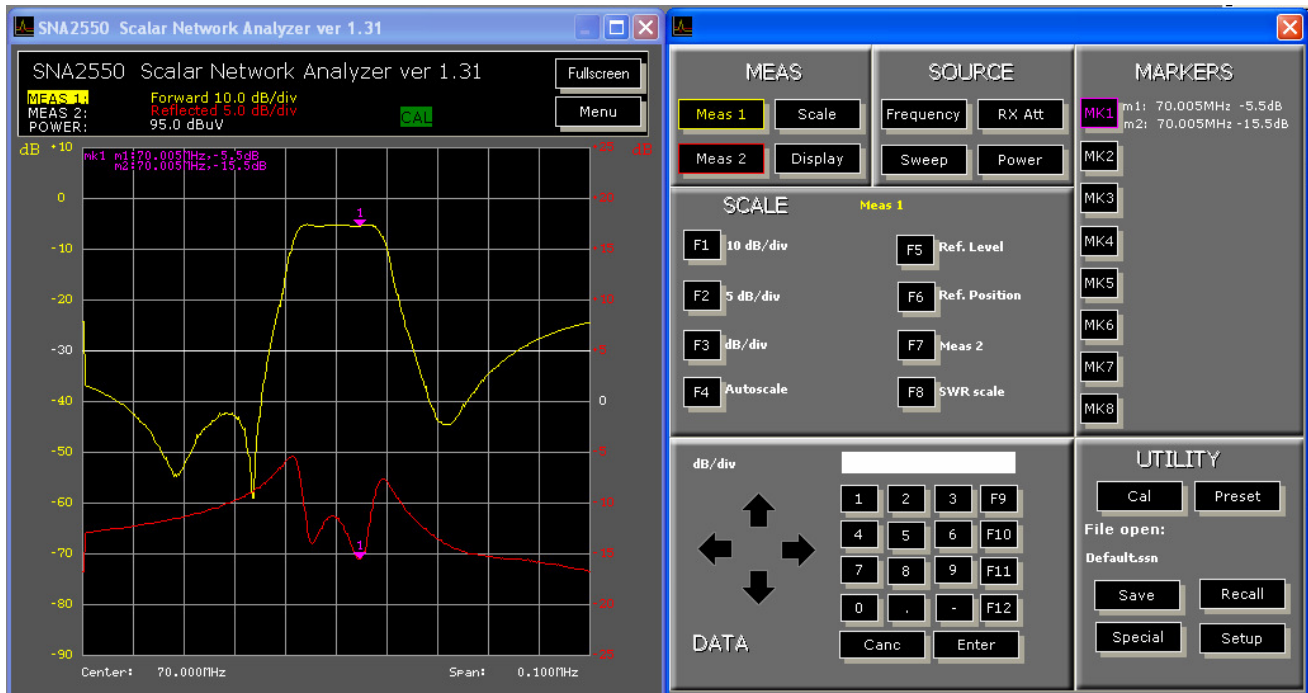
In addition to the functions before described, the software permits other interesting possibilities; in the next, we will explain how to use them.

I. Menu “MEAS 1” and “MEAS 2”



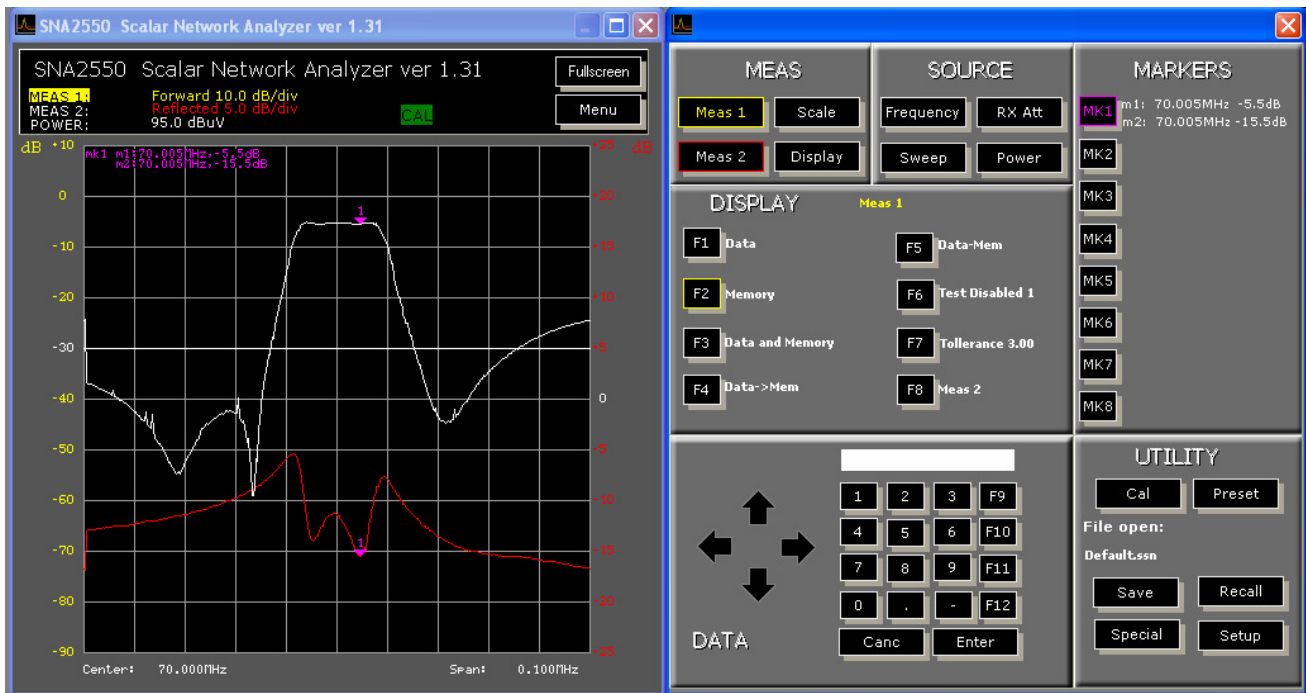
- I.1. To disable the trace belonging to the not desired measurement, click one time (if the measurement is already selected) or two times the corresponding button.
- I.2. Clicking one time more on the button, the measurement will be enabled again.

2. Menù “SCALE”



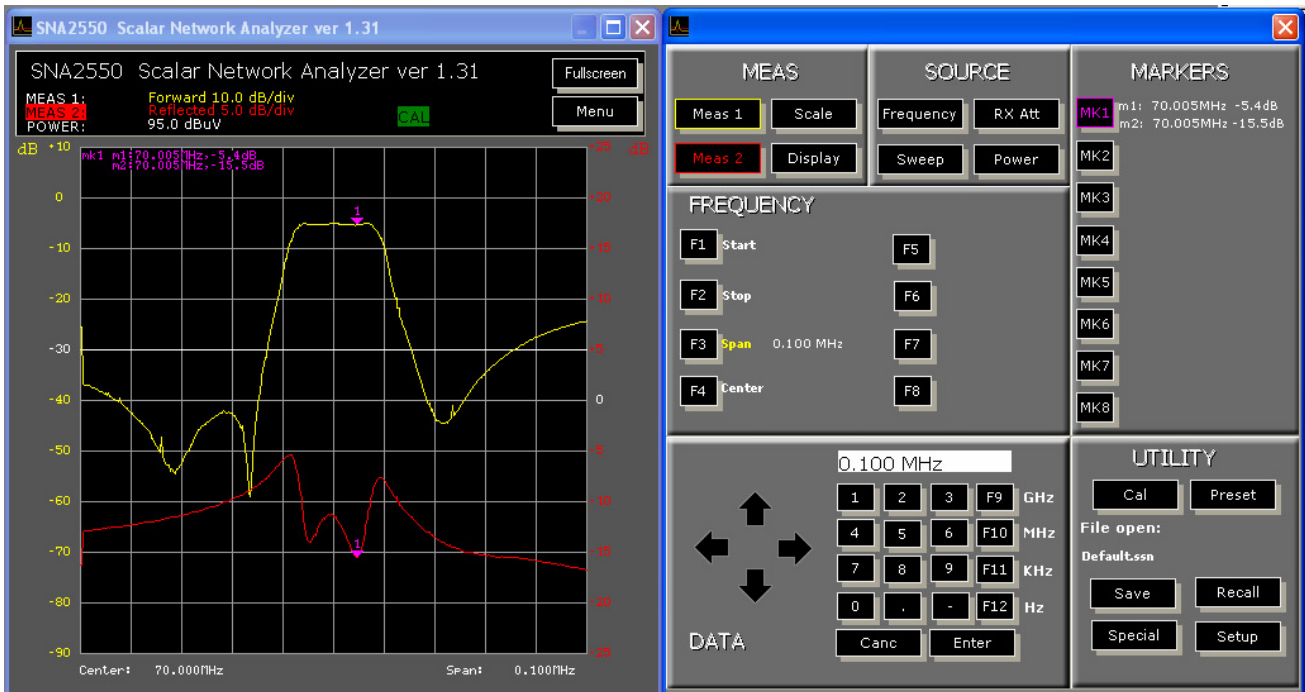
- 2.1. Accessing to the sub – menu “Scale”, the “Meas 1” scale is automatically selected; to access to the “Meas 2” scale, click on the “Meas 2” button of the menu Scale
- 2.2. There are two pre – settled vertical scale factors: 5 dB / div and 10 dB / div;
- 2.3. To impose a different vertical scale factor: digit the desired value then click on the button “dB / div”
- 2.4. The button “Autoscale” permits to modify automatically the vertical scale factor with the scope of having the maximum and the minimum value at top and bottom of the displayed graphic.
- 2.5. The button “Ref Level” permits to modify the level associated with the reference position.
- 2.6. The button “Ref Position” permits to modify the position associated with the reference level.
- 2.7. The button “SWR scale” / “dB scale”, active only for the reflection loss measurement, permits to display the results with a dB scale (reflection loss values) or with V.S.W.R values; the button has a toggle action (every pressing change the scale).

3. Menù “DISPLAY”



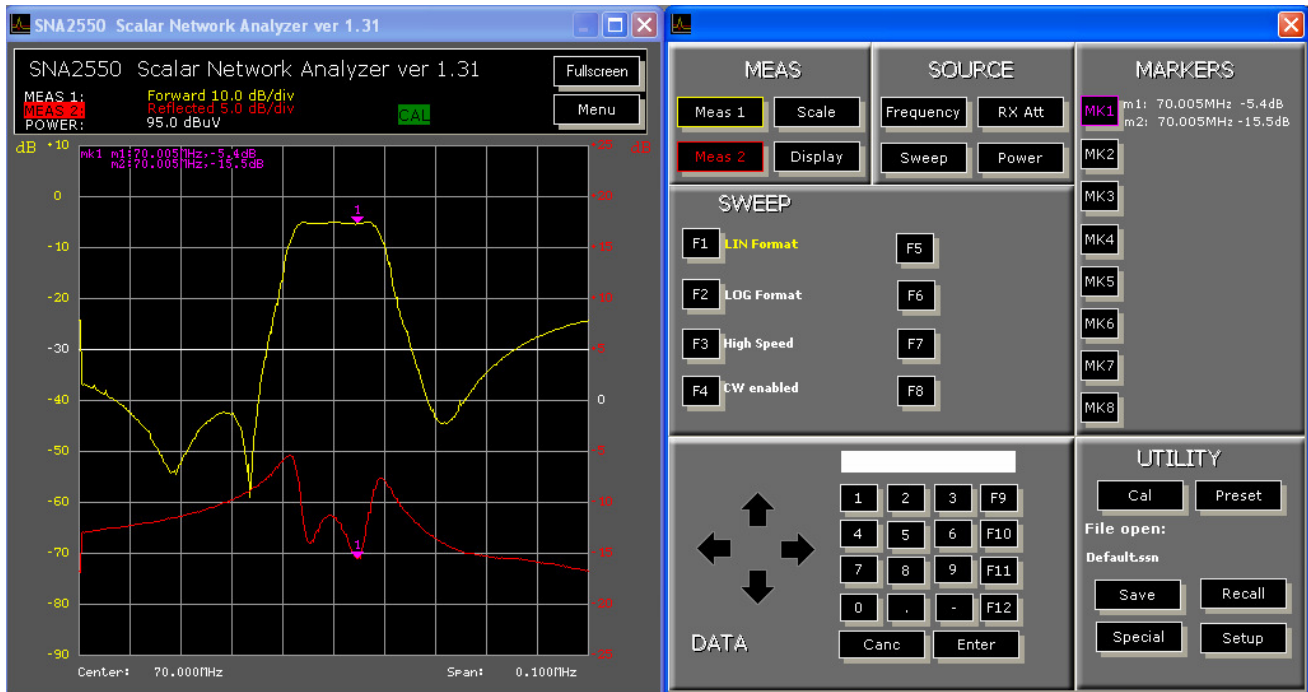
- 3.1. The button “Data > Memory” permits to transfer the select measurement in the trace memory; after this operation the stored trace can be recalled for a comparison with successive measurements; every updating of the memory automatically will restore the display to real time measurement only
- 3.2. The button “Data and Memory” permits to display at the same time the two traces, one for real time measurement and the other for stored measurement (in white)
- 3.3. The button “Memory” permits to display the trace of the memorized measurement only (without real time data of the selected measurement)
- 3.4. The button “Data – Memory” permits to display one measurement trace obtained as difference between memorized and real time measurements
- 3.5. The button “Data” permits to display the trace relative to real time measurement only

4. Menù “FREQUENCY”



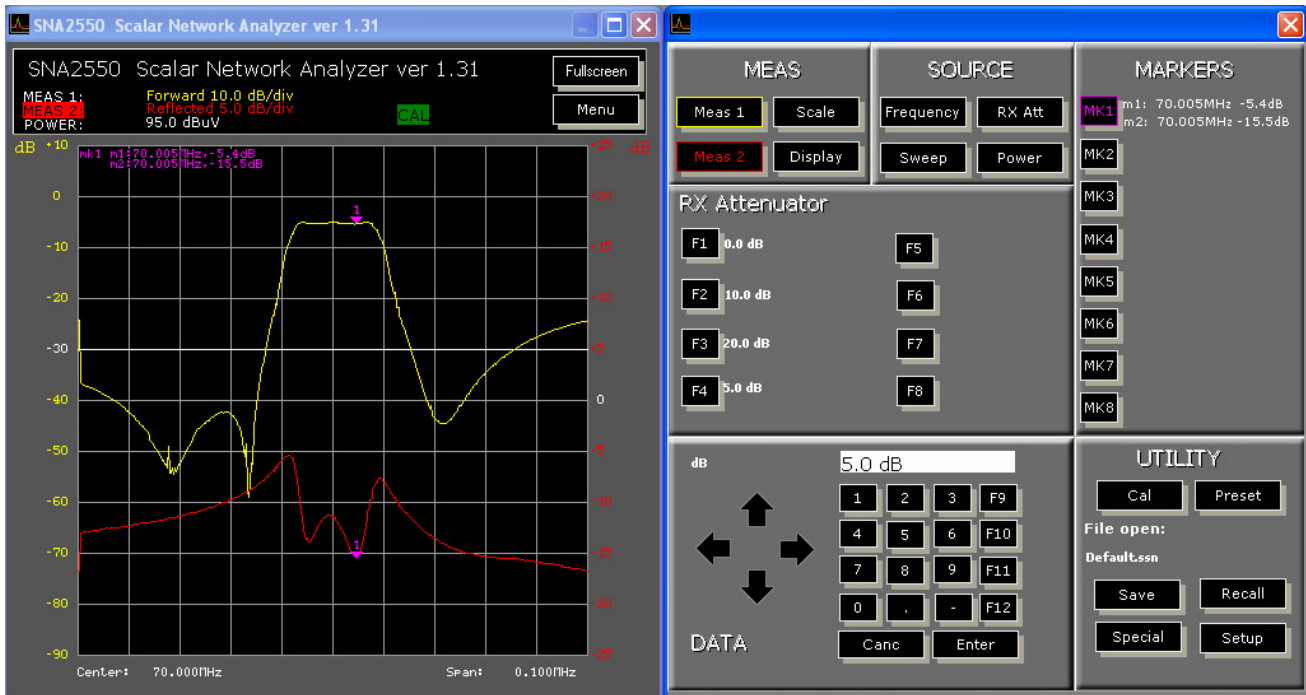
4.1. The buttons “Start” and “Stop” and the couple “Center” and “Span” permit to set the frequency range with two forms; by clicking on a button of a couple, the frequency indication under the graphic, change format automatically

5. Menù “SWEEP”



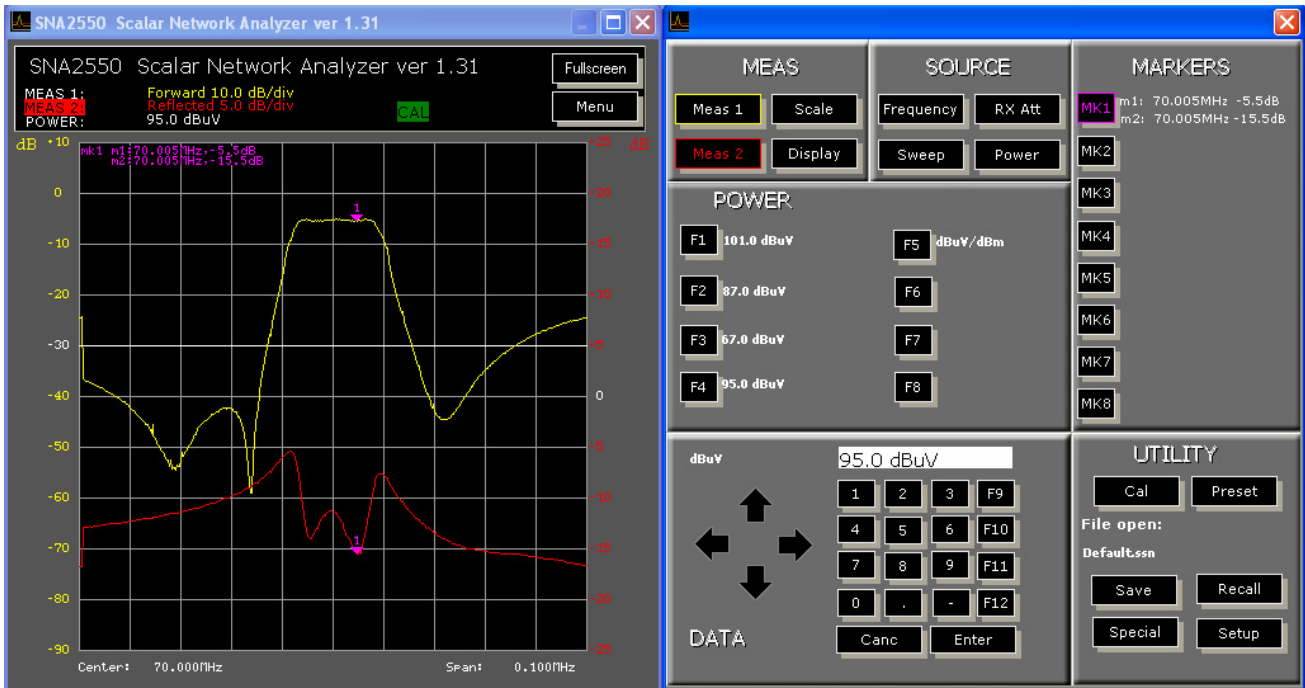
- 5.1. The button “LIN Format” selects a linear frequency scale (all points equally spaced in frequency)
- 5.2. The button “LOG Format” selects a logarithmic frequency scale (points spaced with a constant difference in frequency logarithm, i.e. a geometric succession); this format can be useful for better displaying the low frequency response of a very wideband device)
- 5.3. The button “High speed” / “Low speed” permits to utilize for the measurement 101 or 401 points, making the measurement more fast (easing coarse tuning operation) or more detailed (for better fine tuning)
- 5.4. The button “CW enabled” / “CW disabled” permits to enable / disable the CW (single frequency) mode, with the instruments generating a not modulated carrier for special measurements purpose.

6. Menù “RX Attenuator”



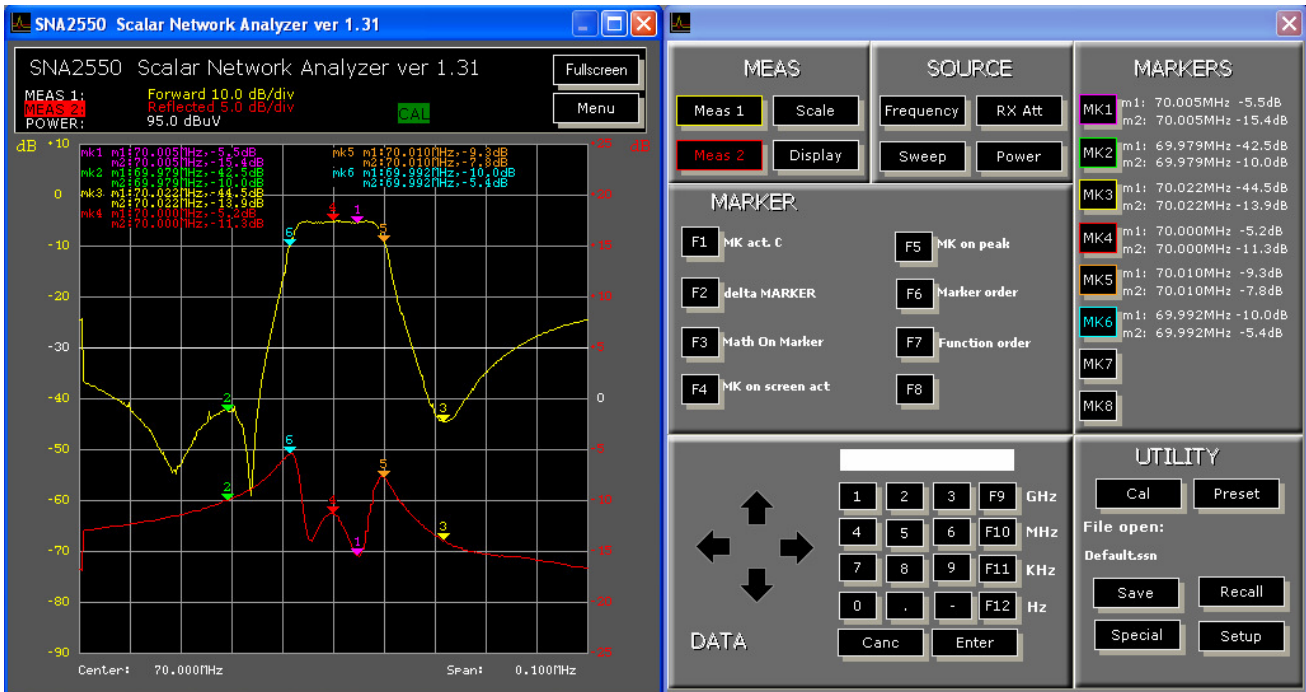
6.1. The operating mode was already described; we advice, after the basic setting, to trying to add 5 or 10 dB of attenuation in order to check if gain varies more than 1 dB: in this case the receiver of the instrument is in compression and the result is not correct

7. Menù “POWER”



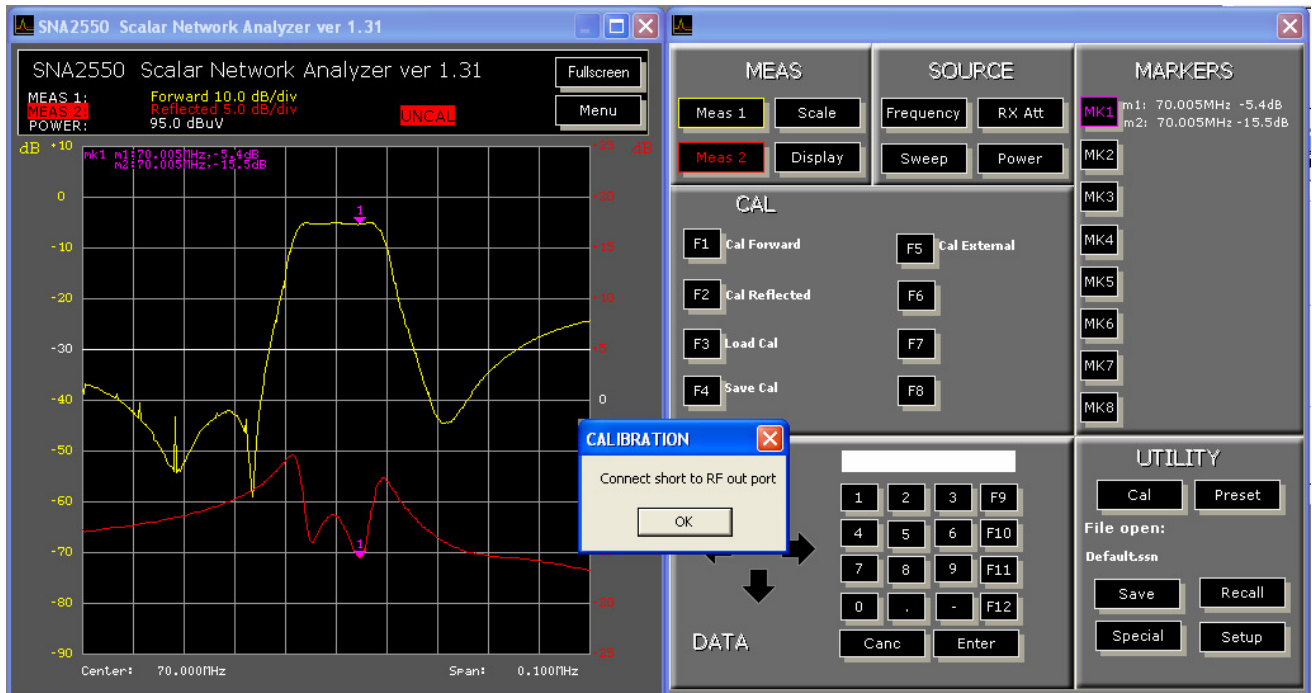
7.1. The operating mode was already described; we advice, after the basic setting, to trying to decrease the level by 5 dB in order to check if gain varies more than 1 dB: in this case the device under test is in compression and the result is not correct

8. Menù “MARKER”



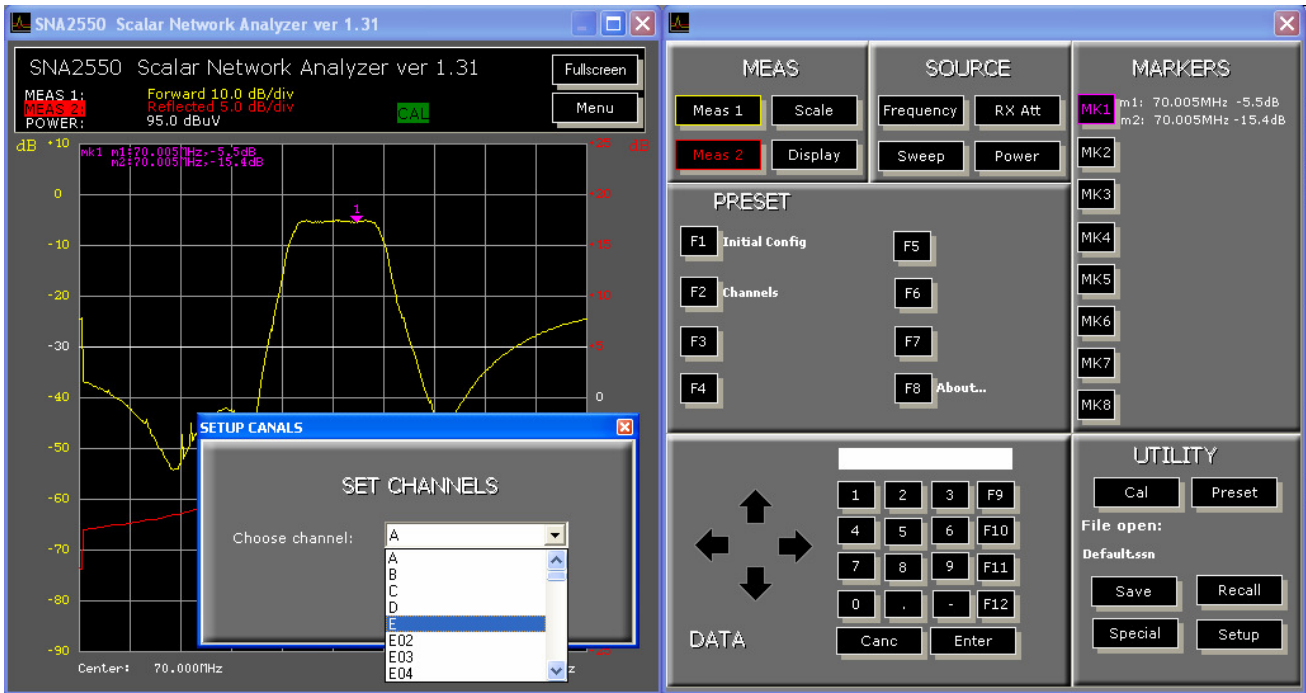
- 8.1. The button “MK act C” shifts the center frequency to the same frequency of the selected marker, leaving unchanged the span bandwidth
- 8.2. The button “Delta Marker” permits to make relative measurements between the marker 1 and the selected marker; the first click enable s this mode (it is visible bottom right on the graphic); the next click disable the mode
- 8.3. The button “Math on Marker” permits to extract automatically the – 3 dB bandwidth (or the – 6, - 30 or another selectable dB value) of a filter or amplifier; to have a correct calculus you must enable three markers and the span bandwidth should be wide enough
- 8.4. The button “MK on screen dis” / “MK on screen en” enable / disable the displaying of marker values on the graphic (they are however always visible in the marker square and it is also unaffected marker positions on traces)
- 8.5. The button “MK on peak” automatically shifts the active marker on the maximum gain point (the function is active also if the forward trace is disabled)
- 8.6. The buttons “Marker order” e “Function order” select the order of presentation of marker values on the graphic: “Marker order” orders the values by marker number; “Function order” orders the values by measurement number

9. Menù “CAL”



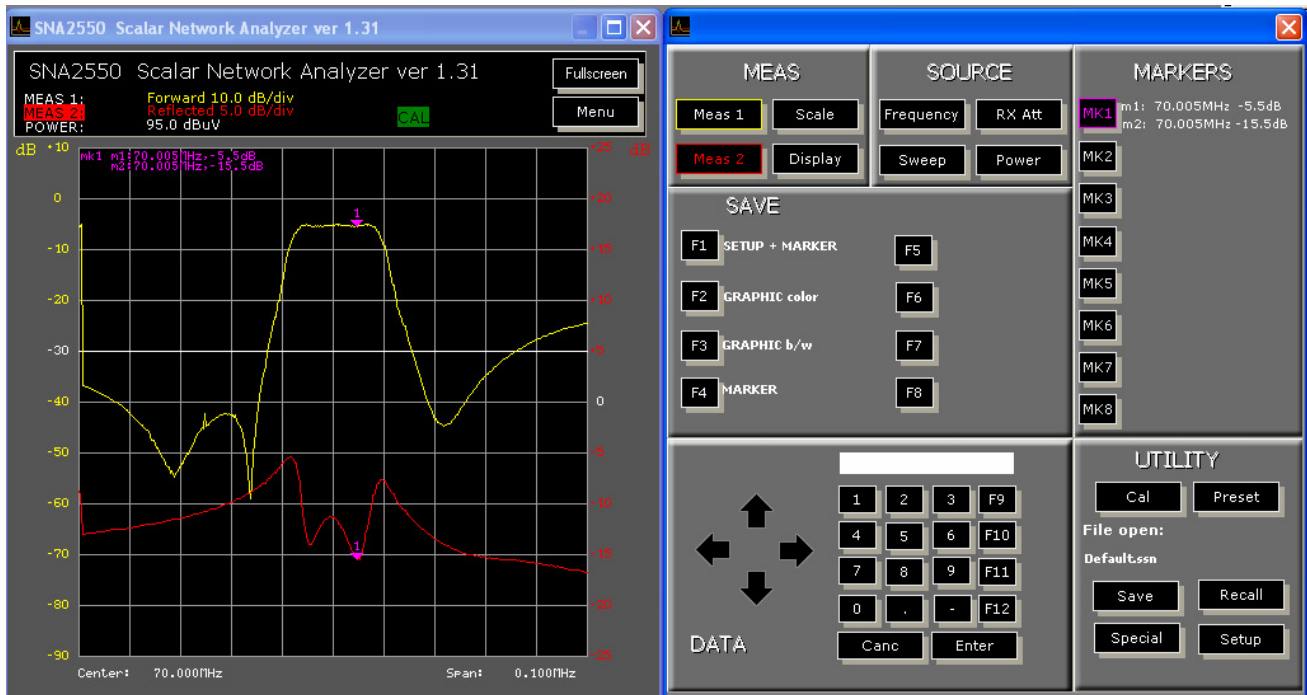
- 9.1. The operating mode was already described: to improve the measurement accuracy, if you connect the device under test with cables whose loss is more than 1 dB, it is better to make FORWARD calibration with that cables and not with the calibration cable; however make sure that connected cables have a return loss better than 10 dB in the measuring band
- 9.2. In the case that calibration procedure should fail to pose traces on 0 dB line, you should repeat that procedure after connection check

10. Menù “PRESET”



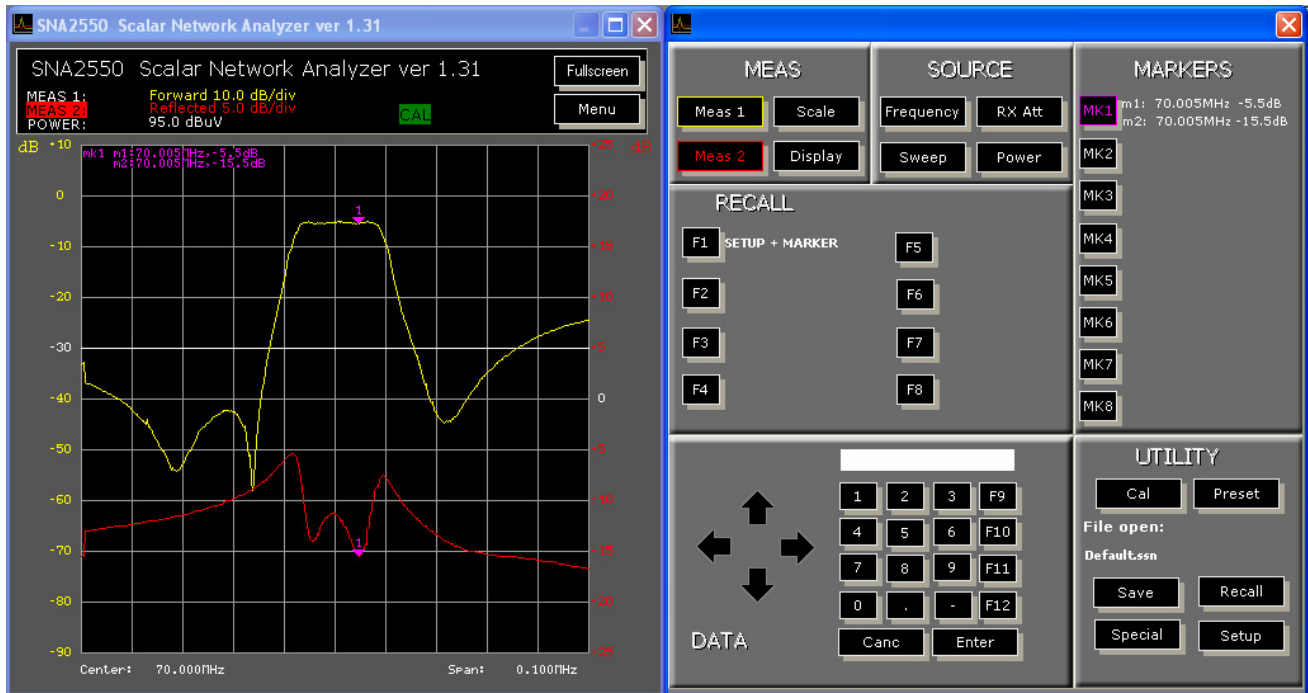
10.1. The operating mode was already described; we only let you know that the setting recalled with the button “Initial config” has not its memorized markers, but it conserves markers from before use in the same position (not the same frequency); closing and then re – opening the program, you will automatically recall the last settings

11. Menù “SAVE”



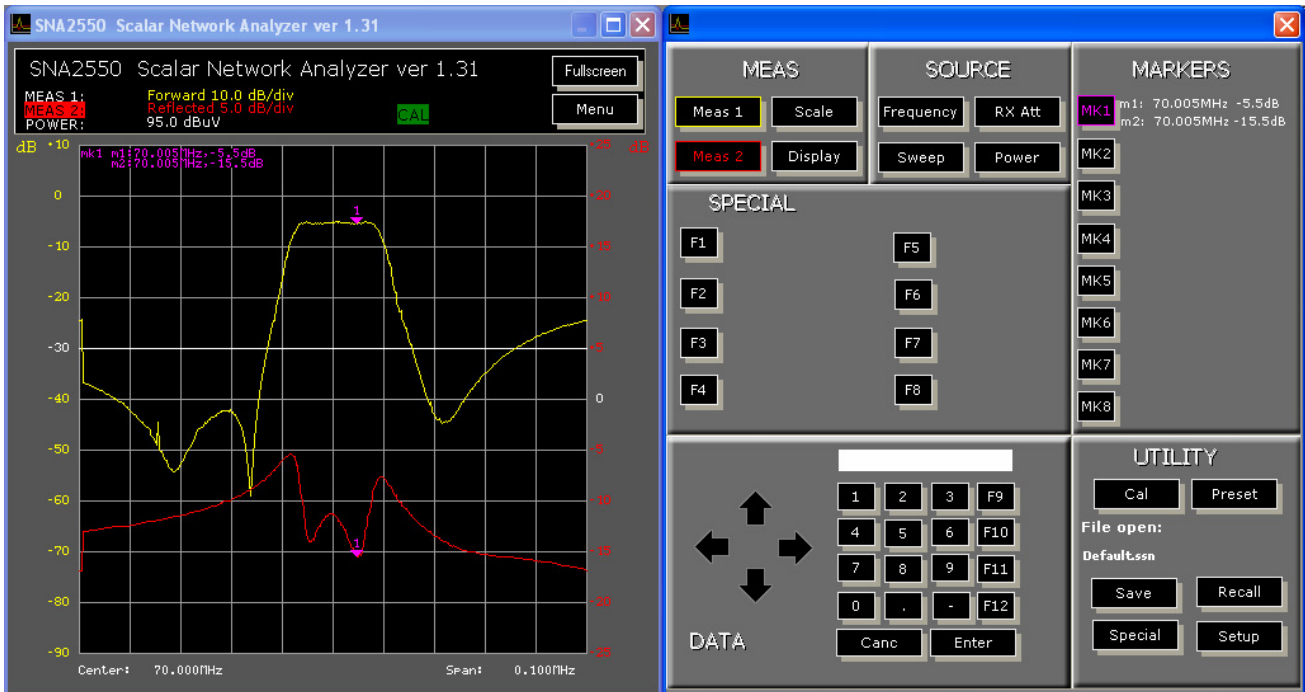
- 11.1. The button “Setup + marker” permits to memorize the measurement settings relative to frequency, marker, generated level and receiver attenuation but not measurement results; the settings are saved in a file with .ssn extension
- 11.2. The button “Graphic color” permits to save on the PC a color image in bitmap format for successive use as document of results
- 11.3. The button “Graphic b/w” permits to save on the PC a black and white image in bitmap format for successive use as document of results
- 11.4. The button “Marker” permits to save marker values in a text file with “notepad” format

12. Menù “RECALL”



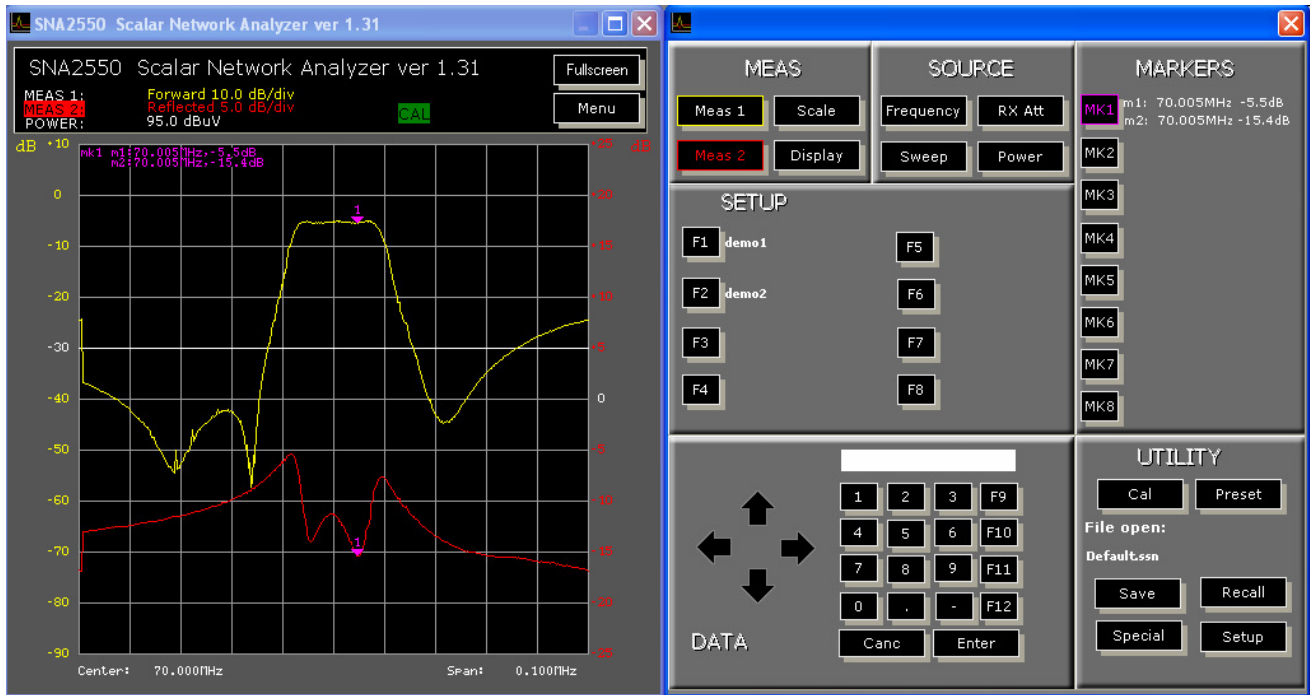
12.1. The only available permits to recall the measurement setting relative to frequency, marker, generated level and input attenuation

13. Menù “SPECIAL”



13.1. This sub – menu is reserved for special function on request from some customs; therefore it is not active normally

14. Menù “SETUP”



14.1. The buttons “Demo 1” and “Demo 2” recall memorized graphics used only for DEMO mode; during normal operation they are inactive

5 Special measurements

Even if it is designed for use mainly as network analyzer, the good performance of the instrument permits to make some other measurements:

1. Un - modulated carrier generator

- 1.1. Selecting the CW mode from the sub - menu "Sweep", the instrument works as a programmable synthesizer with a very fine frequency resolution and with also the output level programmable with 1 dB steps
- 1.2. This operating mode can be useful for the following purposes, for example:
- 1.3. Analysis of the output spectrum of a system, connecting this instrument at the input and measuring the output with a spectrum analyzer or a field strength meter
- 1.4. Measurements on frequency converter simulating the local oscillator
- 1.6. Intermodulation measurements combining its output with another carrier generator (also another ROV 75)

2. Wide band power meter

- 2.3. Imposing a very low generated frequency (for example 1 MHz) and minimum output level, the RF IN port can be used as a flexible wide band power meter, with moderate precision but with a good dynamic range and a good sensitivity (minimum detected level 40 dB μ V; maximum measurable level 120 dB μ V)
- 2.4. You can so measure the output level of a generator or an oscillator; if there are different frequency components, the insertion of opportune filter could enable the measurement of any single component

6 Suggestions for test bench preparing

Even if the instrument is designed for a use without problems, the criticality of the involved measurements can cause significant measurement errors if you don't take some tricks:

- A. The RF IN port is a very wide band meter: therefore any input signal is measured and can modify the results; pay attention to any possible coupling between the circuit under test and cellular or cordless telephone or any other disturbance generator, also at relatively low frequency, like switching power supply without shielding; use always coaxial cables with high shielding (avoid, possibly, or limit to absolute minimum the use of terminals or open wires) and, if necessary, insert filter for rejecting interferences between circuit and RF IN port
- B. Long cable with high loss modify heavily the reflection loss measurement: every dB of loss reduces by 2 dB the reflected power; use always very low loss cables
- C. Non linear devices followed by narrow band filters can generate elevated harmonic components and so simulate circuit response at sub – harmonic frequency of the filters band: special attention to frequency converters with single bipolar transistor
- D. If your circuit to be tested requires, for linear operation, an input level lower than 80 dB μ V, the reflection loss measurement is affected by high error: in this case, we advice you to perform the gain measurement with this low level and then make the reflection loss measurement with a higher level (at least 80 dB μ V)
- E. If the device to be tested is a high loss filter, to utilize the full dynamic range of the instrument, it is better to insert a wide band and well impedance matched amplifier between the filter output and the RF IN port; similar is the case of a filter with low pas – band insertion loss and elevated stop – band attenuation: in this case you should make two measurements: a normal measurement for pass – band loss and with the amplifier connected for band –stop loss (warning: use an amplifier with an output power not dangerous for the instrument)
- F. If the device under test is a not linear circuit of high power, more than the power limit of the RF IN port, you should insert an attenuator between the circuit output and the RF IN port; that attenuator must have a nominal power higher than the amplifier output and an attenuation level equal or higher of: (maximum circuit output voltage in dB μ V) – (full scale instrument voltage in dB μ V)

7 Credits

- Windows 2000 and Windows XP are registered trademark of Microsoft Corporation
- USB 2.0 is a registered trademark of USB IF

Operating Manual Rev. 01_2 of 10/2006

Rif. SW 1.31

Declaration of Conformity

The product marked as

SNA-2550

manufactured by

Manufacturer: ELAD S.r.l.

Address: Via Col De Rust, 11 - Sarone
33070 CAVEVA (PN)

is produced in conformity to the requirements contained in the following directive:

➤ 89/336/EEC (Electromagnetic compatibility)

The product respects the norms on the electromagnetic compatibility:

EN 55022 (1999): Apparecchi per la tecnologia dell'informazione. Emissione: limiti e metodi di misura

EN 55024 (1999): Apparecchiature per la tecnologia dell'informazione. Immunità: limiti e metodi di misura

And further amendment.

This declaration is under responsibility of the manufacturer:

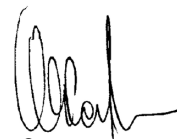
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33070 CAVEVA (PN)

Issued by:

Name: Franco Milan
Function: President of ELAD

Caneva
Place

March, 2nd 2006
Date


Signature