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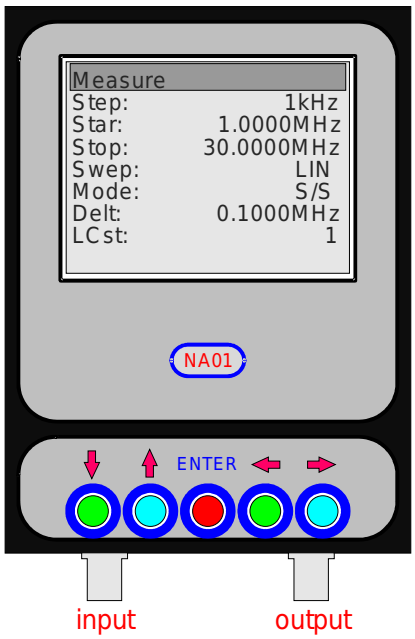
NA01

0.5-30MHz universal circuit Analyzer

description / manual

(06.2014)



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Contents

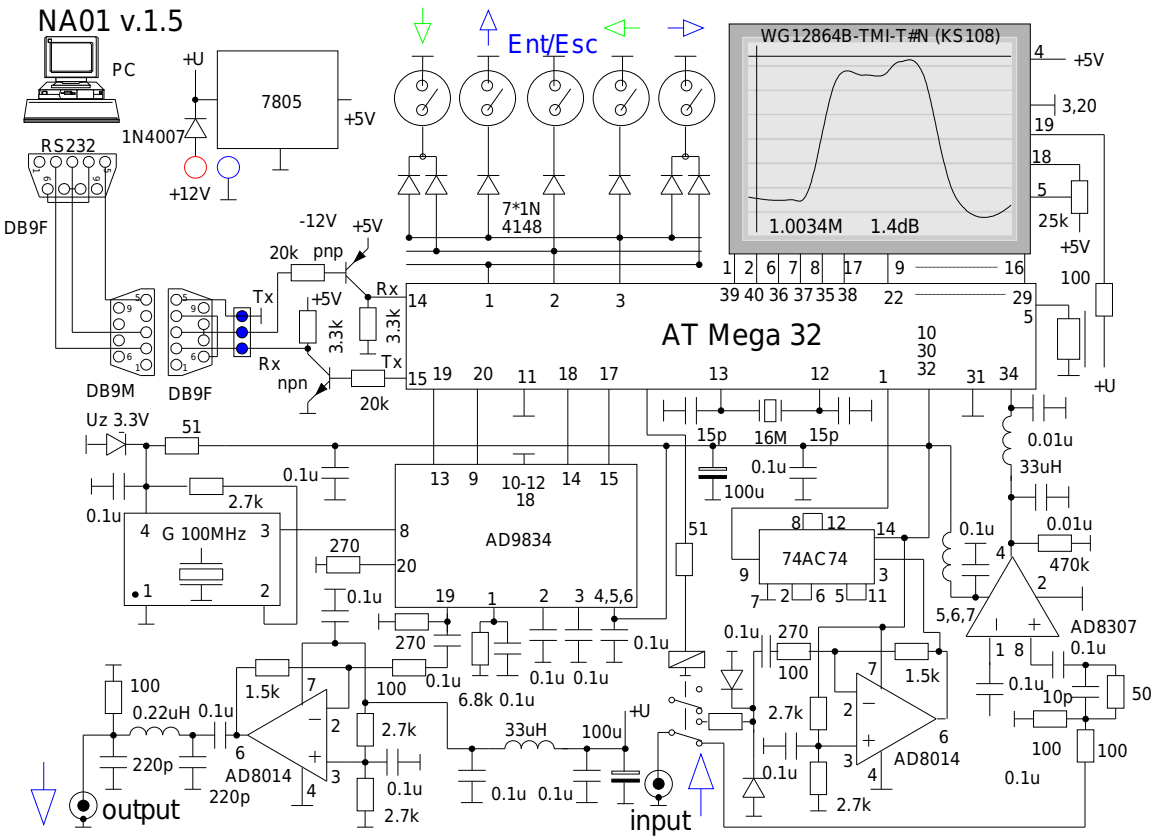
1 NA01 analyser – Basic information

NA01 is simple but multifunctional measurement device working independely of PC computer in frequency range 0.5-30MHz. Device can measure:

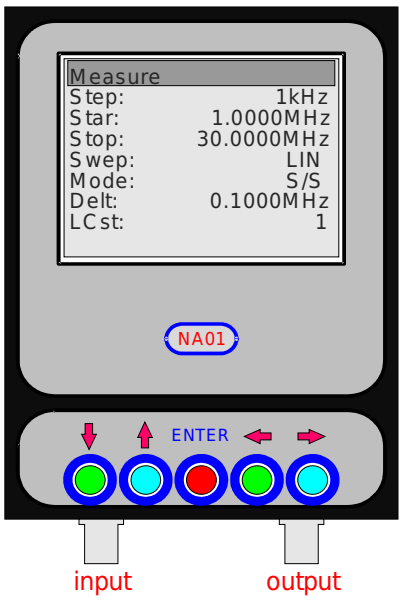
- RF circut characteristics in ordered frequency range as linear or logarithmic mode
- SWR connected antenna or other device with SWR bridge as add-on
- RF power with additional add-on (50 ohm dummy load about 10W, -27dB)
- L, C, Q and X-tal with additional add-on based on serial rezonance frequency measurement
- Frequency spectrum anlyze with additional mixer as add-on
- Frequency of RF signal up to 32MHz.

1.1 Working principle

Main functional elements of NA01 are: DDS AD9834 generator, AD8307 logarythmic detector, AT Mega32 processor, 5 button keyboard and 128/64 pixels display. According to more complex measurements, 4 additional add -on's are provided with 3 BNC/BNC cables. Device is supply with internal 9 pcs of 1.2V/0.7A. cells or from external power supply 12-14V/1A.



2 Manual



2.1 **Push buttons**

Device is managed with 5 navigation push buttons.

Two left buttons allow to move between menu positions during measurement preparation and moving horizontal line measured value during measurement process.

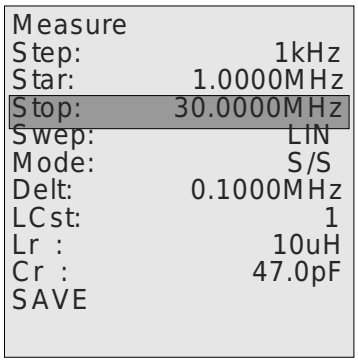
Two right push buttons allow to change value on selected menu position or moving frequency mark vertical line during measurement process.

Middle (red on pictue) push button acts as „Enter" to accept selected values or as „Esc" to leave actual measurement mode.

2.2 **Main menu**

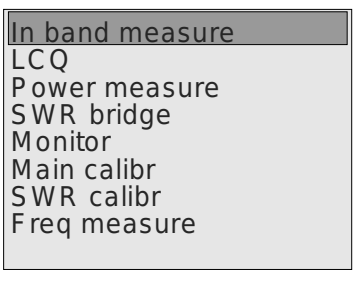
Main Menu is the first screen which is appearing just after power on device. Active menu position is indicated by highlighted line. Main menu allow to configure/change measurement parameters and save it for future use. Menu position means:

- Measure - this is link to second menu level (measurement choise). Accept jumps to measurement menu by middle push button



- **Step** – change frequency step value from 10Hz to 1MHz
- **Star** – measurement start frequency [MHz]
- **Stop** – measurement stop frequency [MHz]
- **Swep** – sweep style: **LIN** as linear between **Star/Stop** and **LOG** as logarithmic between **Star/Stop**
- **Mode** – sweep mode as **S/S** (**Star/Stop**) or **Delt** - (**Star** + **Delt**)
- **Delt** – sweep range [MHz] starting with **Star** frequency
- **LCst** – **Lr**, **Cr** change step [0.1-1000]
- **Lr** – reference inductor value [uH]
- **Cr** – reference capacitance value [pF]
- **SAVE** – saving values showed on **Main menu** screen in nonvolatile memory for current and future use.

2.3 **Measure menu**



Measurement menu consict several possibilities regarding particular measurement and measurement preparations. Positions in this menu means:

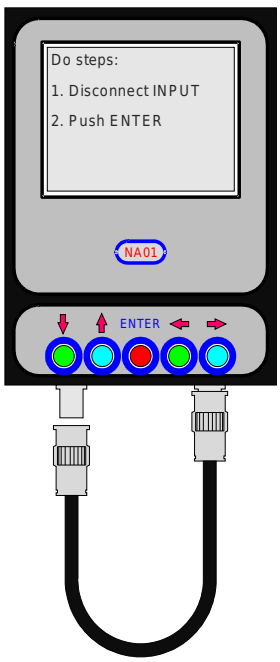
- **In band measure** – shows attenuation characteristic against frequency. Can be measured with linear as well logarithmic

frequency manner. This measurement needs previous execution **Main calib** procedure before first measure or when frequency range was changed significantly.

- **Measure + Q** – allow serial resonance (LC) circuit measurement and X-tal frequency and quality. Measurement require using LCQ add-on and previous execution **Main calib** procedure before first measurement or when frequency range was changed significantly.
- **Power measure** – power measurement with add-on support from uW up to several tens of W. Custom add-on can extend measurement possibility up to hundreeds of W. This measurement needs, once done, initial calibration based on well known power value or inner signal.
- **SWR bridge** – shows SWR characteristic against established frequency range. Measurement is possible with additional add-on bridge and reference load (abt. 50 ohm). This type of measurement needs previous execution **SWR calib** procedure before first measurement or when frequency range was changed significantly.
- **Monitor** – working with measurement mixer add-on and show frequency spectrum regarding measured signal.
- **Main calibr** – procedure support **In band measure**, **Measure + Q** and **Monitor**. Must be done once at start or when measurement conditions are changed significantly.
- **SWR calibr** – procedure support SWR bridge measurement, Must be done once at start or when measurement conditions are changed significantly.
- **Freq measure** – allow for signal frequency measurement from 20uW up to 1W in range 0-30MHz

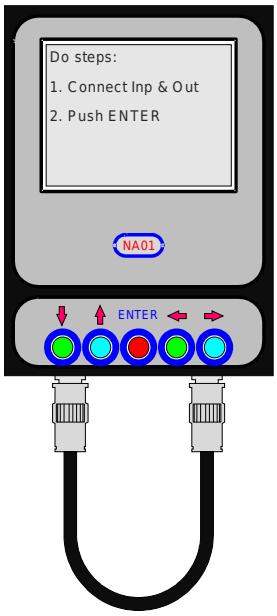
2.4 **Main calibration**

Main calibration is important for **In band, LCQ** and **Monitor** measurements. Should be done once after power on and setting require frequency range or when frequency range was significantly changed eg. from 1-30MHz to 20-24MHz. Calibration is running in two steps described on the screen:



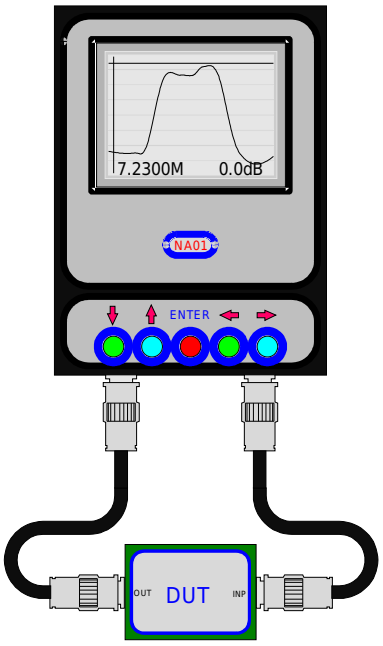
1. First calibration step should be done when **Input** is disconnected or closed with 50 ohm load
2. Second calibration step should be done when **Input** is stright connected with **Output.**

One main calibration should be done in 1-30MHz range just after power on and used later in the same frequency range or for less accurate measurements in other frequency ranges. But he best accuracy is obtained when separate calibration is done for every frequency range.

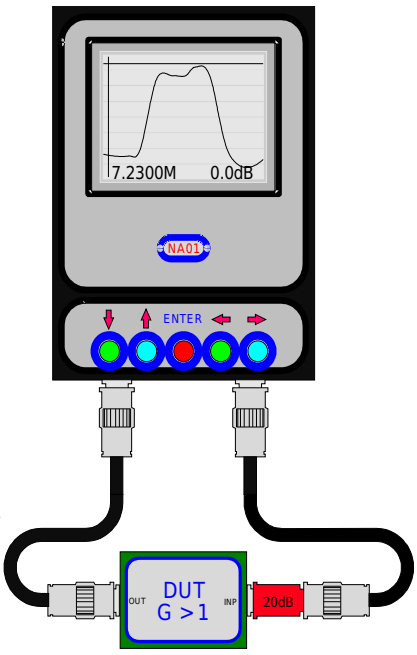


2.5 **In band measurement**

2.5.1 **Passive and active devices measurements**

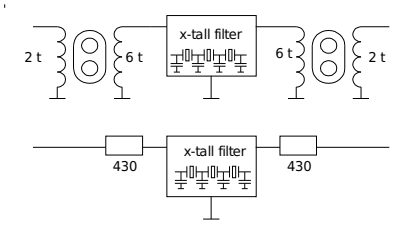


Passive devices (with **G**ain < 1) can be measured directly and then attenuation values on the display are directly what device represents. Active devices must be measured with attenuation no less than maximum active device gain.and then real gain of devece must be calculated as actual attenuation value + used attenuator value. When **Swep** is linear than possible is change frequency range just on the measure screen with vertical marker. Moving marker in left or right direction behind actual range cause change **Star** or **Stop** frequency about 10% up or down. This rule is actual as well for SWR measurements.



2.5.2 **Narrow band measure**

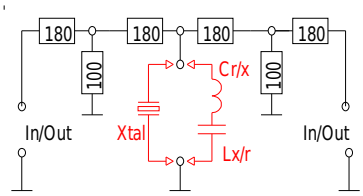
Narrow band devices, like quartz filters, must be measured with special care because of measurement resolution. Measurement screen has 128 measurement points between **Star** and **Stop.** This way current measurement frequency step has value (Stop-Star)/128. For example when

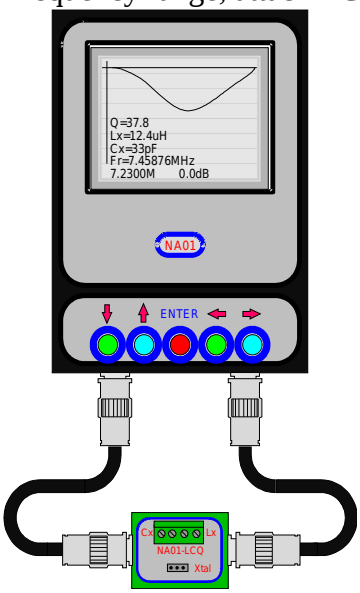


Star=1MHz oraz **Stop**=11MHz then measurement step is (11MHz-1MHz)/128 = abtout **78kHz** and could be grater than quartz filter band. First measurement will be done at 1MHz, second at 1.078MHz, third at 1.156MHz and so on. Is it more probably that NA01 don't even see narrow band device in such condition. In described case measure range should be no more than 10 times of expected device band. For quartz filters use 20 or 40 kHz range and fit it later to require, smaller value. As raw rule use for first attempt measure, range (**Star-Stop**) no wider than 50 times than expected device band. To measure more detailed transmition band of quartz filter use additional 20-30dB attenuator. First do **Main calibr** with added attenuator. Such way measure resolution will be much more comfortable to regulate device in transmition area but measurement dynamic will be smaller.
Second problem regards NA01 impedance and measured device impedance. NA01 has 50ohms impedance so for example to fit to quartz filter (impedance about 500ohms) use serial resistance about 430 ohms or, as better choice, use transformer with 9 times impedance change (eg. two whole ferrites with 2/6 turns 0.3-05mm Cu wire as showed on above picture).

2.6 **LCQ measurement**

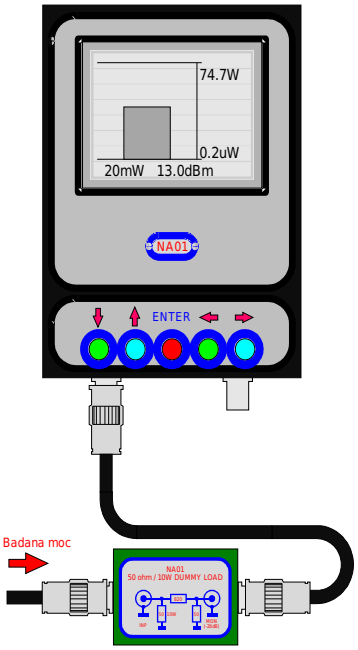
Use LCQ add-on to measure Lx, Rx, Q or X-tal's parameters. First, setup frequency range, attach LCQ add-on and do **Main calib** procedure when no L, C or X-tal elements are connected to add-on. Next connect serial LC circuit or X-tal to connectors and choice LCQ measure. For serial resonance circuits frequency range can be as much as several megaherts around probably resonance frequency. For X-tals use rules described for X-tal filters and use at first attempt frequency range no more than 10-50kHz around X-tal resonance frequency. Measurement screen shows parameters of measured resonance circuit or X-tal: resonance frequency, quality of circuit (X-tal) and serial equivalent Lx, Cx parameters for established previous in Main menu values Cr and Lr. Lx and Cx measurements has sense only for resonance circuit measurements. For well known capacitance, Cr, system finds equivalent Lx inductor and for well known inductor, Lr, system finds equivalent Cx capacitance as well circuit serial resonance frequency.

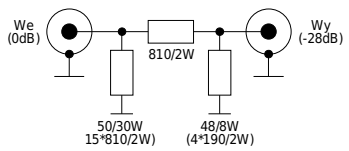




2.7 Power measurement

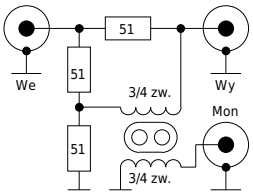
Power measurement require power add-on and **never do measure power without add-on because of main device damage possibility**. Attached add-on works as 50 ohm 10W dummy load and about 27dB attenuator. Because of 10W power capacity, is possible short (couple of seconds) measure power up to 50W. To extend power range use custom dummy load with power fitted to require power range and measurement attenuation 25-30dB. Power add-on has coloured ends with **RED** and **GREEN** . Use **RED** end to connect to measured power source and **GREEN** to connect to NA01. Power measurement require once power calibration for particular power add-on used to measures. To do calibration follow information on screen using well known external power source 1-100mW or use as reference signal from NA01 output (about 32mW). For external sources, to estimate power, use formula P=Upp*Upp/400 where Upp means peak-peak sinus signal value on osciloscope.

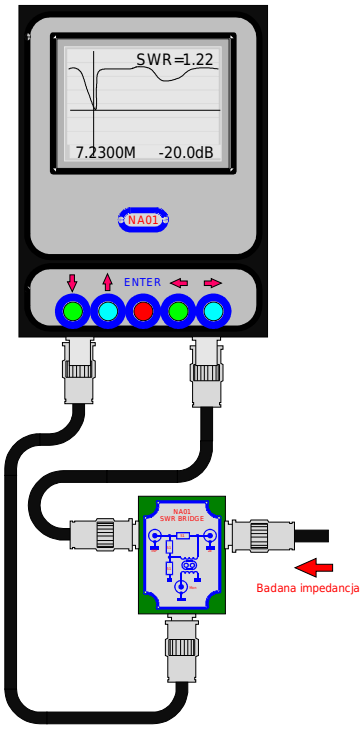




2.8 SWR bridge

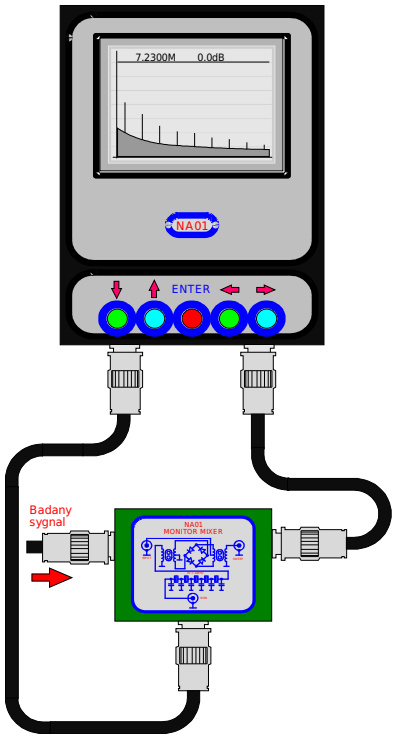
SWR bridge is working as clasical four-arm balanced circuit add-on with 50 ohms reference load. . For proper using, setup measurement frequency range and connect add-on like on the picture. Next do **SWR calib** using reference load follow to information on the screen. SWR measure is simplest way to check antenna quality and can avoid risk od power amplifier damage. . Measurement result is scalar value between 1 and infinity. Value 1 means that measured device (eq. antenna) has impedance equal 50ohms. Big SWR or close to infinity means that connected device has very small (short) or very big impedance (open) against 50 ohms. SWR close to 1 means better condition for power amplifier. Generally, SWR should be below 3 because it means that more than 75% power is going to the antenna and only 25% left in power amplifier devices.





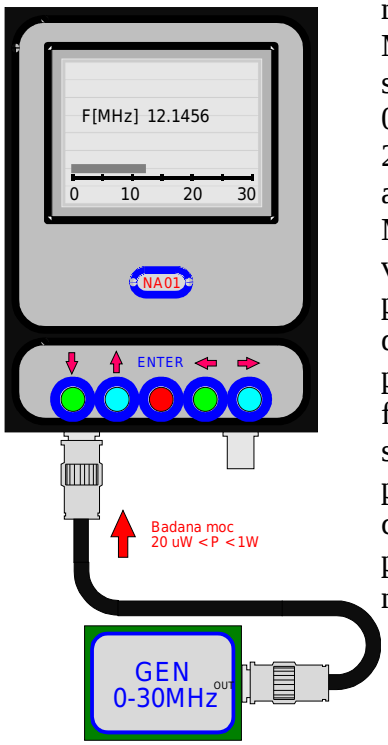
2.9 Monitor

Monitor add-on this is double balanced mixer and narrow band (about 3-4kHz) quartz filter about 32MHz working pass frequency. In this case NA01 works together with add-on as receiver with 3-4kHz pass band, so posssible is measurement resolution better than 5kHz. Na01 output works as hetrodyne in range 31.5-0.5MHz and is lower than 32MHz filter frequency so this implicate reverse result direction on the display. For proper function this measure required **Main calib** procedure with connected add-on in **counted** frequency range. If measure frequency range lays between Fmin and Fmax then on Main screen frequencies Star and Stop should be established according to formula: **Star=32-Fmin** and **Stop=32-Fmax** (all values in MHz). Spectrum analysis is time consuming procedure, so for widest range (1-30MHz) can take as much as 10 seconds. Measurement results on the screen it is gray background and sharp harmonic marks. Harmonic frequency and it's relative level can be read out with vertical and horizontal navigation lines.



2.10 **Freqency measurement**

Frequency measurement is simplest between the others procedures. Just connect source of measured signal to **Input** and choice **Freq measure** from menu. Measurement range starts almost from zero up to 30MHz. Measured signal level should be no less 20mW (about 20mV) and no more than 0.25W (about 3.5V). Use power add-on for signals with level bigger than 250mW. Measure procedure scans input signal about 3 times per second and shows result on display as graphic horizonatl bar and digital value. Measurement is based on microprocessor clock (16MHz X-tall) and can vary from one NA01 device to another. Use external reference signal to precisely adjust measurement result. Corection in plus and minus can be done with horizontal navigation push buttons (right buttons). Just push proper button and hold it until result on the screen will fit to external frequency source value. Na01 allow to use inner frequency - 5MHz signal from DDS to do proper frequency calibration. In this case use first power measurement procedure just to start inner signal source. You cannot connect any add-on or power source, just make full measurement procedure. Measurement frequency corection is remembered in nonvolatile memory until next correction.



3 Operation conditions

- **Do not measure power without power add-on.** Power add-on should be properly directed **RED end to source** of signal and GREEN end to NA01 Input. Do not measure power bigger than 10W with default power add-on longer than couple of seconds because of add-on and NA01 damage risc.

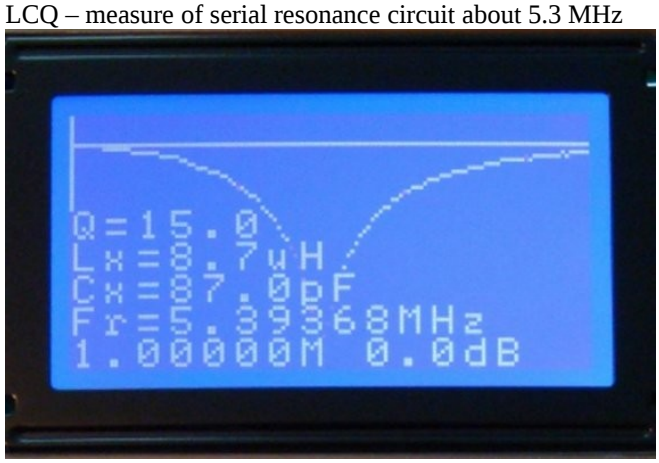
- **Do not** connect to **Input** signal **higher than 250mW** (abt. 3.5V)

- For battery loading use current **no more than 200mA** at loading start.

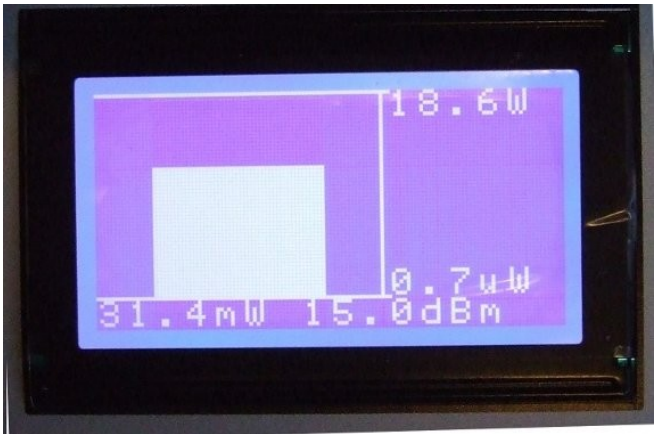
4 Measure examples

In band measure – narrowband x-tal filter

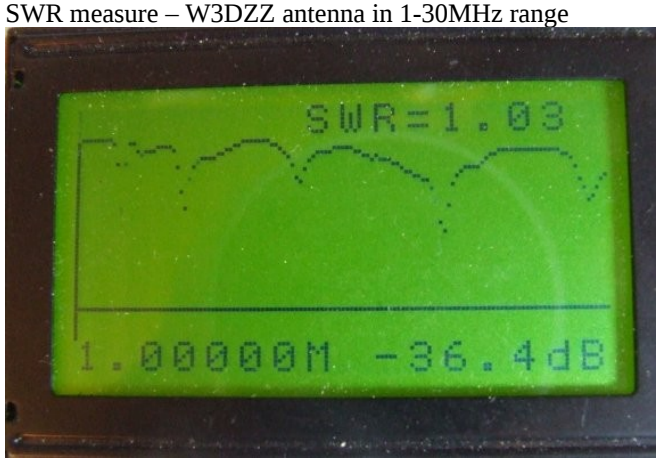
LCQ – measure of serial resonance circuit about 5.3 MHz



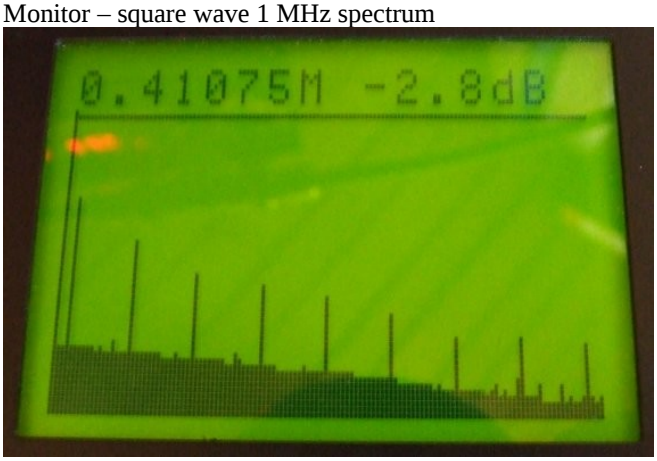
Power measure



SWR measure – W3DZZ antenna in 1-30MHz range



Monitor – square wave 1 MHz spectrum



Frequency measure (inner 5MHz source)