

Description of TinySA a real Spectrum Analyzer for little money

Introduction:

The emergence of a number of Vector Network Analyzer with the name NanoVNA has led to Hugen, who is responsible for the production and delivery of NanoVNA-H and NanoVNA-H4 as well as NanoVNA-V2_2 where the latter is with either SMA or N connectors, together with Erik Kaashoek has developed a Spectrum Analyzer, named TinySA, in the same price range, which is a great product with many advanced features.

This entire product program is stocked in Denmark by EDR and purchased via EDR WEBShop, at a price that makes it silly to buy online at Alibaba.com or elsewhere, as the price at EDR with VAT matches several weeks waiting time, hassle with Post Nord, which must have a few hundred Dkr. to charge VAT and handling. If you use DHL for the shipment from outside DK, you will also receive a corresponding extra bill.

When you receive a TinySA, it comes in a nice gift box, as shown in Figure 1 which contains the TinySA itself and a USB C to USB-2 cable, 2 pcs. SMA male-male test cables, an SMA female-female adapter and a wrist strap with a guitar pick to operate the menu system, via the touch sensitive color screen.



Figure 1

When you turn on TinySA, it automatically starts in the frequency range 0 to 350MHz and as can be seen in Figure 2, the noise floor is -90dBm. The small antenna has captured a TV signal and marker 1 finds the largest signal automatically

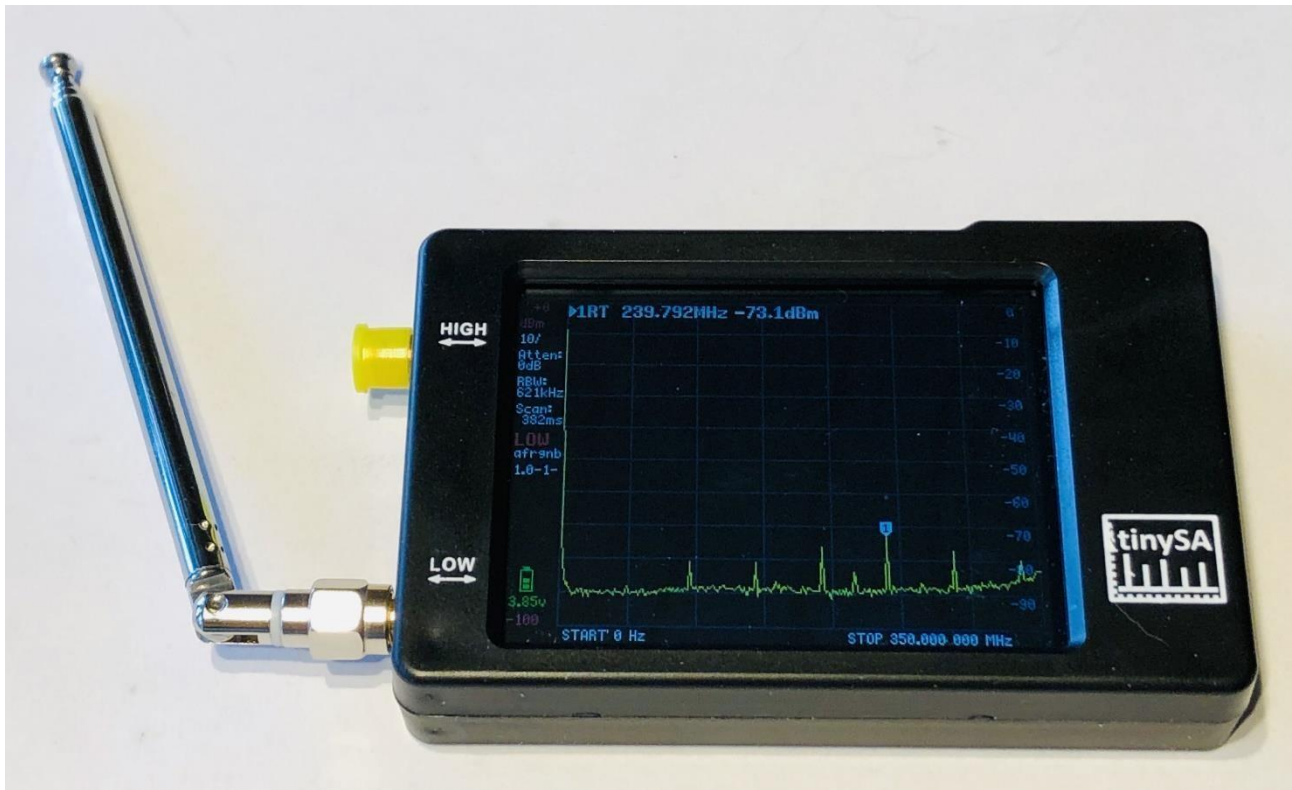


Figure 2

It is programmable via the USB cable so that, whoever is not stuck on the fingers, can make smart programs that control TinySA. There is already a PC Software that downloads screenshots, of which facilitates this document and some examples shown here, showing an AM modulated signal with 70% modulation in Figure 3, as well as phase noise measurement for a 30MHz signal at a distance of 0.5MHz with top text 2 show the measurement with the value -110.9dBc / Hz shown in Figure 4.

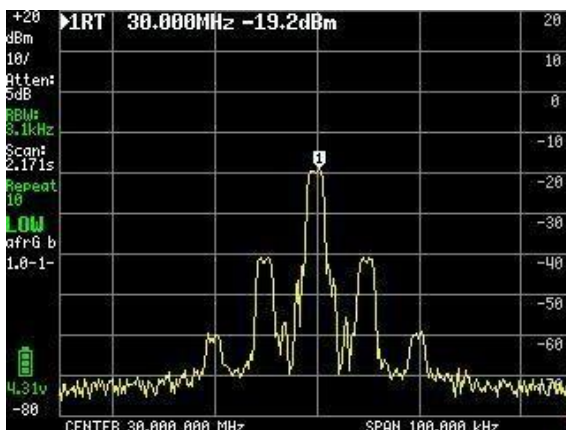


Figure 3

AM signal with 70% modulation



Figure 4

Phase noise measurement for a 30MHz signal

There are four markers with different individual functions. Likewise, one can turn on a waterfall and monitor a selected frequency range, and with many further functions to store and remember Max or Min levels. TinaSA can do many things besides the basic function as Spectrum Analyzer, with 6 filter band widths from 3KHz to 600KHz, in two frequency ranges 0.1 to 350MHz with super performance, within + - 1dB accuracy, and one expands frequency range from 240 to 960MHz with a some reduced data.

These extra things that even a professional SA does not always have are:

- Harmonious analysis of e.g. an oscillator or a transmitter
- Automatic measurement of OIP3 f (3rd order intermodulation) of an amplifier or a PA stage
- Phase noise of an oscillator, transmitter or amplifier

- Signal generator with output signal for both the two frequency ranges, with programmable frequency and signal level from -6 to -76dBm for the low range, with AM and FM modulation and a sweep with optional dB step function, up or down for linearity measurement, and user selected sweep range, over the entire range of 0 to 350MHz. For the high frequency range, with signal level from -38dBm to +13dBm with 16 pre-defined levels.

- 0 sweep (CW) at selected frequency, which acts as a kind of oscilloscope, or as a Power meter as the readout is selectable in either dBm, dBmV, dBuV, Volt or Watt.

It is very recommendable to visit <https://www.tinysa.org/wiki/> where you can go in depth and get a lot of detailed information, with a number of small video clips, and where there is also a link to the PC program TinySA.exe and the latest firmware revision.

So let's look at the different options available with TinySA

The start-up screen shown in Figure 5 contains a wealth of information on the left side. From above shown 0 dBm as reference level, then 10/ which means 10dB per division from 0dBm down to -100dBm, Atten: 0dB (attenuator 0 dB automatically selected), RBW: 621kHz (filter bandwidth that is automatically selected for the fastest possible sweep) pending frequency span, Scan: 406ms (a full sweep of 0.406second) LOW (the low frequency band selected).

In addition, battery voltage is shown as well as a bar showing the capacity left, here 100%. At the bottom a green progress line when sweeping

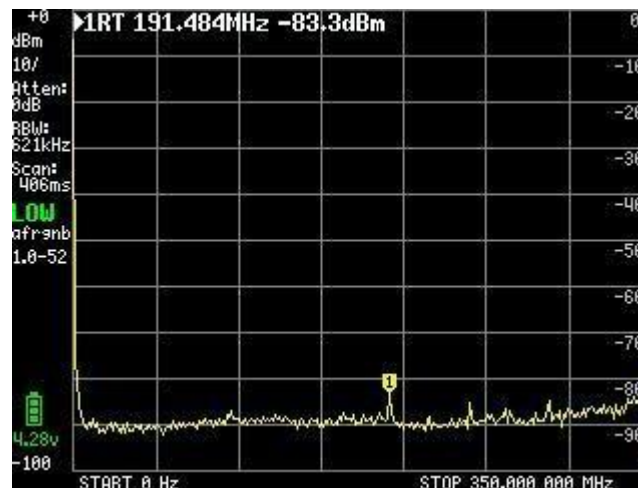


Figure 5

A click on a random point on the screen or a tap on the rocker switch at the top right of the cabinet, brings up the main menu on the screen shown in Figure 6.

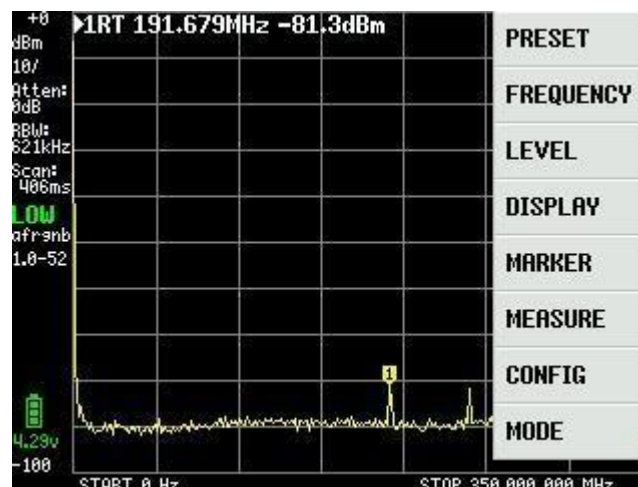


Figure 6

MAIN MENU

MODE submenu as shown in Figure 7 with submenu items appears by clicking on MODE:

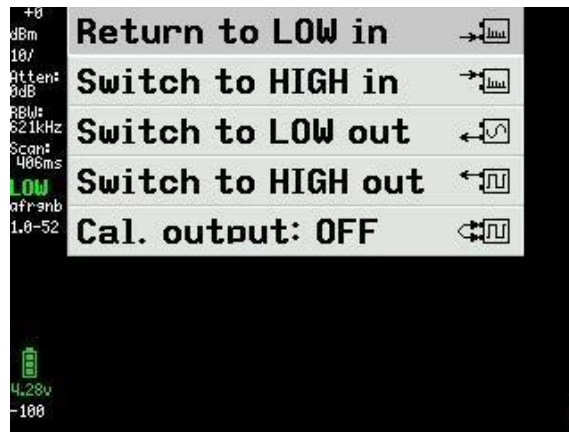


Figure 7

By clicking on "Switch to HIGH in" we get a new screen Figure 8 with the frequency range 240 to 960MHz and the input signal must now be connected to the SMA connector called HIGH

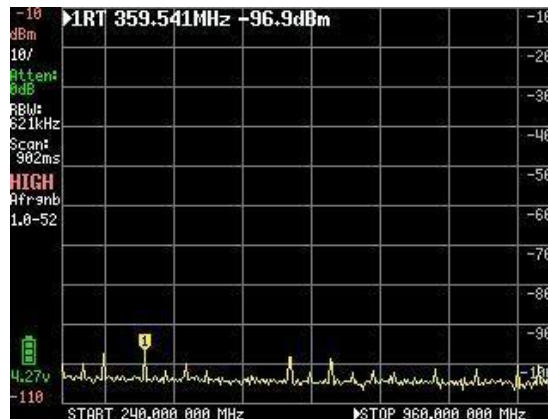


Figure 8

A little about TinySA as a signal generator which can be read later, but practical to know something about before the actual review of TinySA as a Spectrum Analyzer, as there is references to these functions.

If you are impatient, skip to Figure 26

TinySA is also a signal generator with advanced functions, and by clicking on "Switch to LOW out" in figure 7, this submenu appears as Figure 9. For the time being, LOW OUTPUT is set to OFF until all settings have been made.

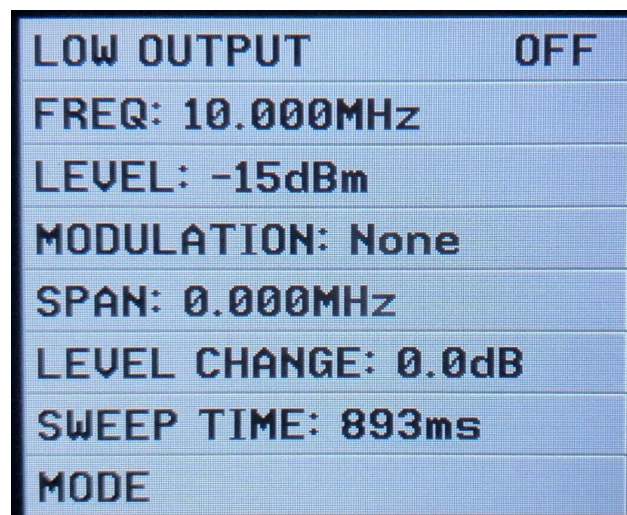


Figure 9

A click on FREQ: in figure 9 an input field opens Figure 10 where the center frequency can be set from 0 to 350MHz with a frequency dependent step resolution of 400Hz at 349,999MHz and 200Hz at 10MHz.

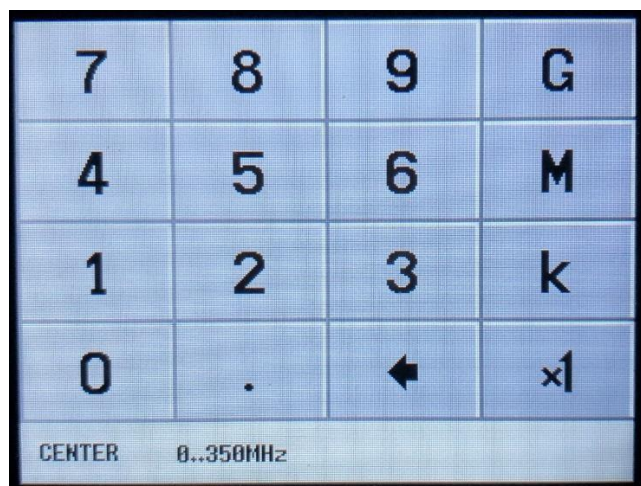


Figure 10

A click on LEVEL: in figure 9 allows selection of output level in 50 ohms from -76dBm to -6dBm in 0.5 dB step via the input board figure 11

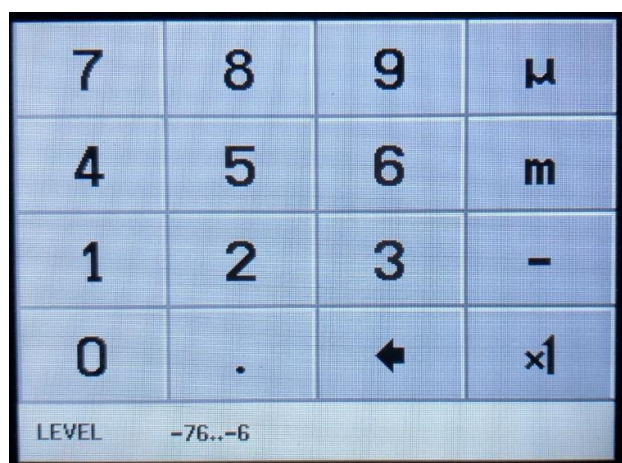


Figure 11

A click on MODULATION: in figure 9 lead to Figure 12 and brings up the menu where we can select the modulation forms shown. They are with a great deal lot of distortion and are used to monitor if e.g. a receiver operates on AM and / or FM

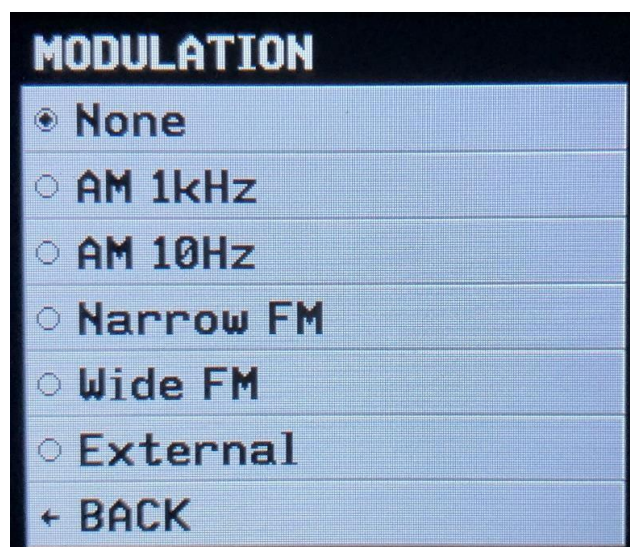


Figure 12

A click on SPAN: in Figure 9 allows setting the sweep width in Figure 13 from 0 to 350MHz symmetrical around the selected center frequency, with a resolution of the same order of magnitude as for the center frequency

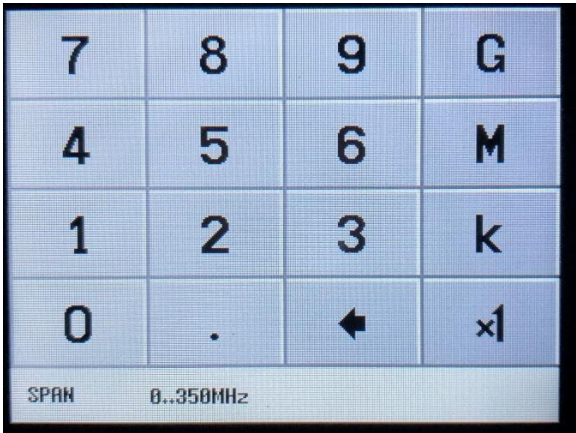


Figure 13

A click on the LEVEL CHANGE in Figure 9 opens up for a sweep, with the output level selected by Figure 11 to sweep with increasing or decreasing amplitude by 0.5dB step over a range of 70dB selected in Figure 14

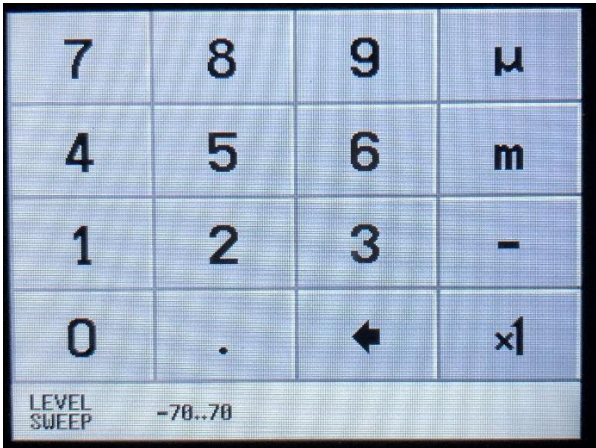


Figure 14

If we select a LEVEL CHANGE of -30dB at Figure 14, a new screen will appear with the selected frequency of 10 MHz, a SPAN of 0.000 MHz and a changed output level to -20dBm, selected at Figure 9, and a SWEEP TIME of 5 seconds , we get an overview of the image on the screen as shown in Figure 15. First now we set LOW OUTPUT to ON

With another TinySA, this amplitude sweep between -20 and -50dBm is shown at a sweep time of 10 seconds in Figure 16. A convenient way to assess the linearity of an amplifier or a PA Step

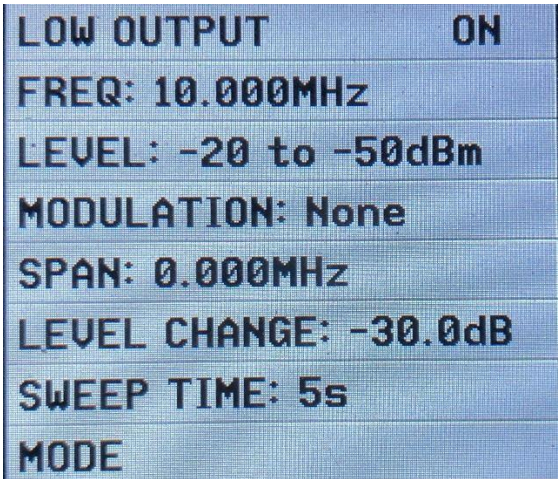


Figure 15

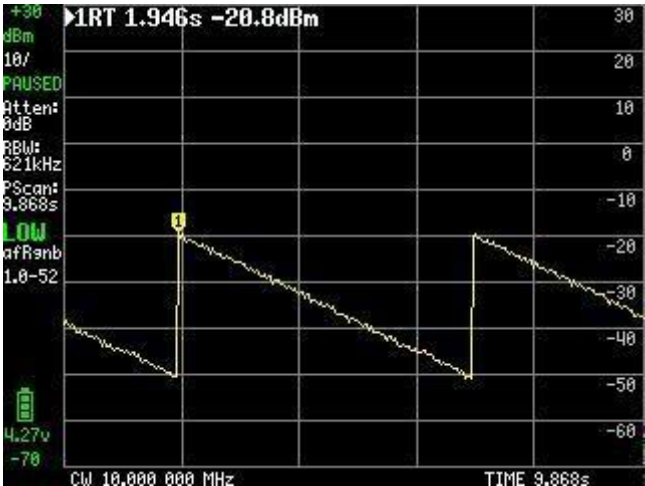


Figure 16

The SWEEP TIME setting can be set up to 600 seconds in Figure 17

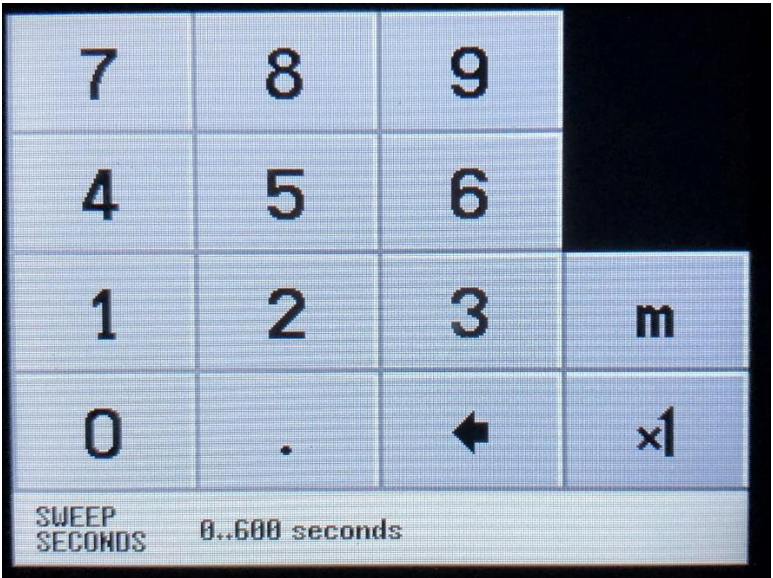


Figure 17

When selecting “Switching to HIGH output” in Figure 7, a similar set of menu items appears in Figure 18 as for LOW output. The frequency range is 240 to 960MHz but certain functions are less flexible and for example LEVEL CHANGE does not exist.

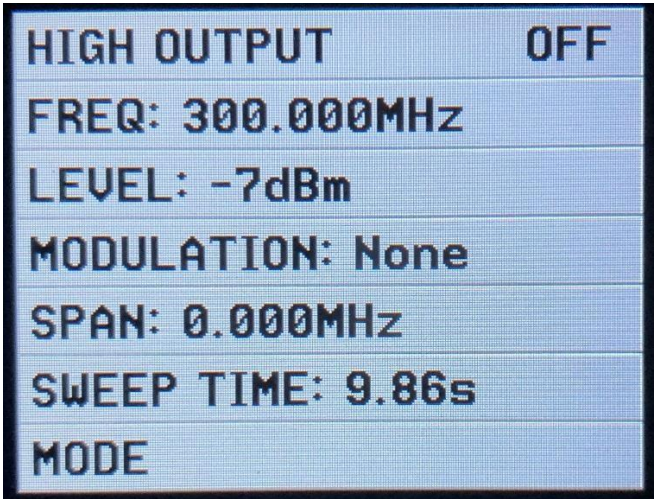


Figure 18

When selecting FREQ: in Figure 18, this can be selected from 240 to 960MHz in Figure 19

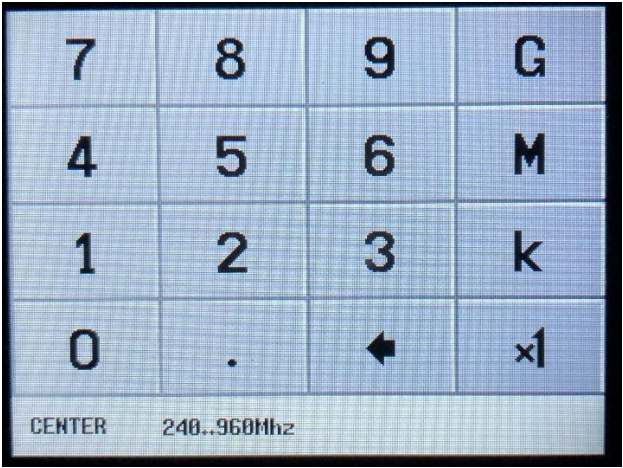


Figure 19

When selecting LEVEL: in Figure 18 a series of menus for fixed output levels appear ranging from + 13dBm down to - 38dBm shown in Figure 20 to Figure 22

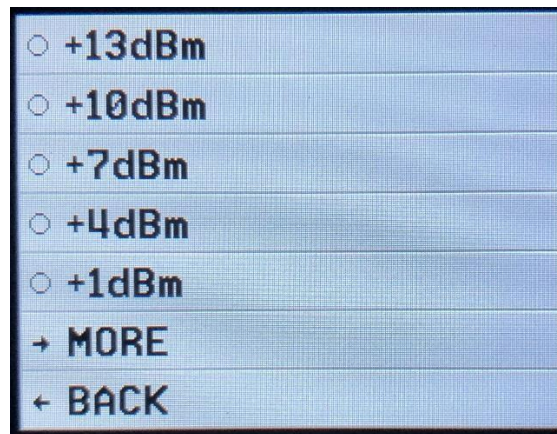


Figure 20

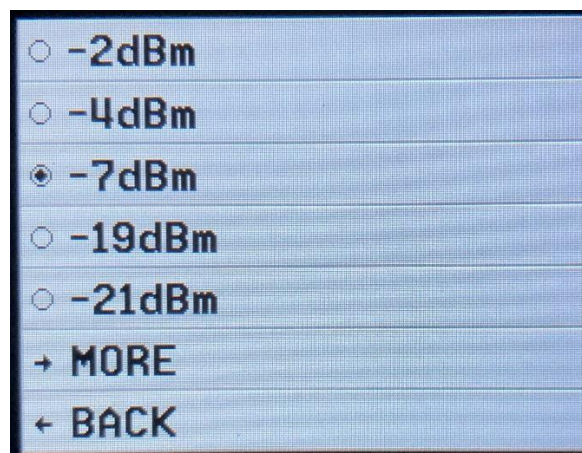


Figure 21

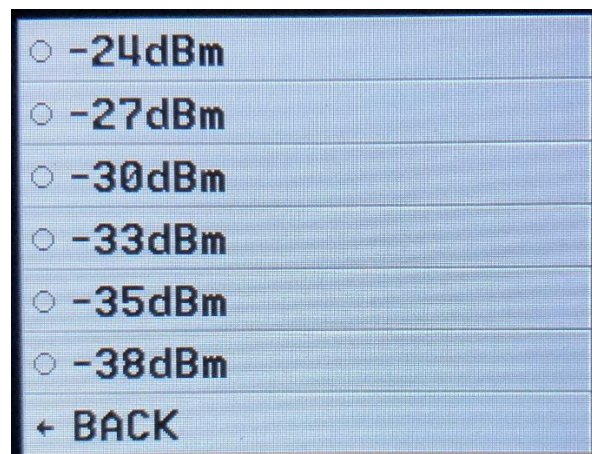


Figure 22

When selecting MODULATION: in Figure 18, the two FM modulation forms can be selected. AM cannot be selected as shown in Figure 23

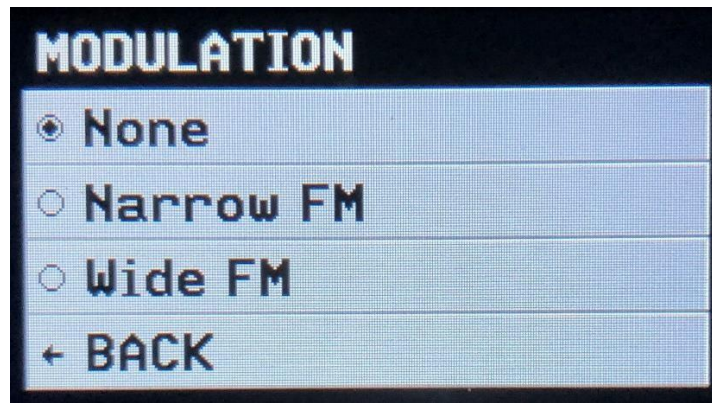


Figure 23

When selecting a SPAN: In figure 18 you select a span via Figure 24 which is symmetrical around the selected frequency in Figure 19 and TinySA checks whether this is within the frequency range 240 to 960MHz. If the selected span is too large, a new center frequency is calculated automatically

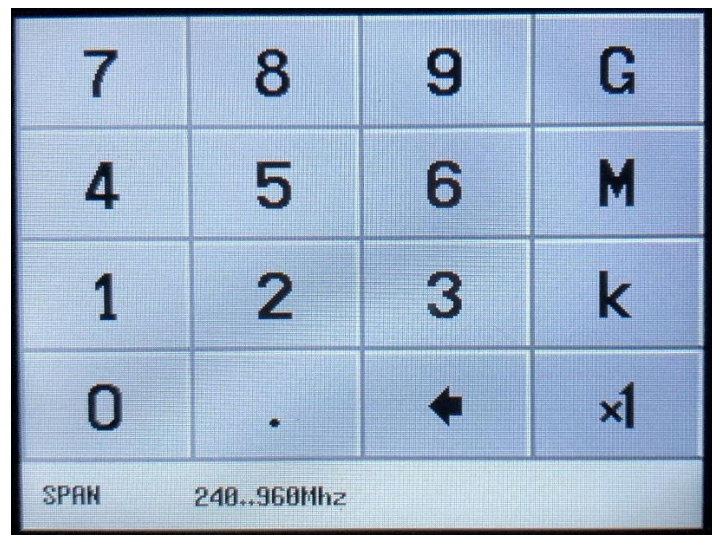


Figure 24

If SWEEP TIME is selected: in Figure 18 it can also be set in Figure 25 up to 600 seconds

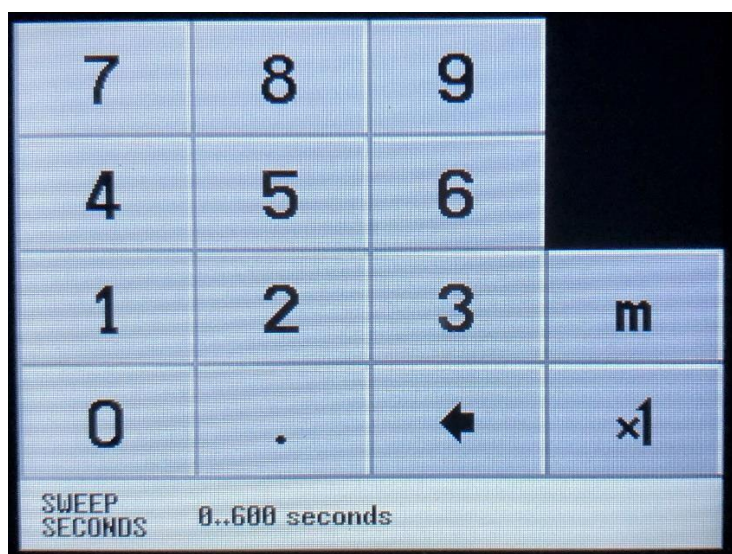


Figure 25

When everything is set as desired, set HIGH OUTPUT to ON in Figure 26

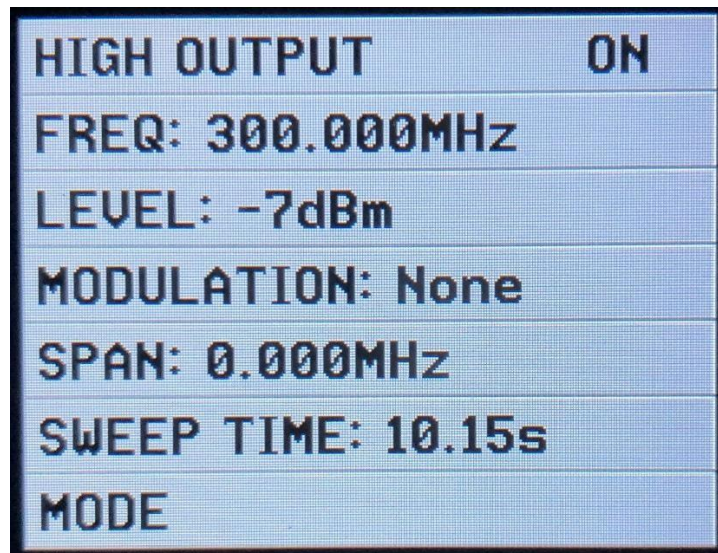


Figure 26

When choosing Cal. Out: in Figure 7 a test signal selection is provided in Figure 27 which is used for different purposes. The 30MHz signal is used by TinySA to perform SELFTEST and signal level calibration, as this level is quite accurate -25dBm

We must first become acquainted with these two functions.

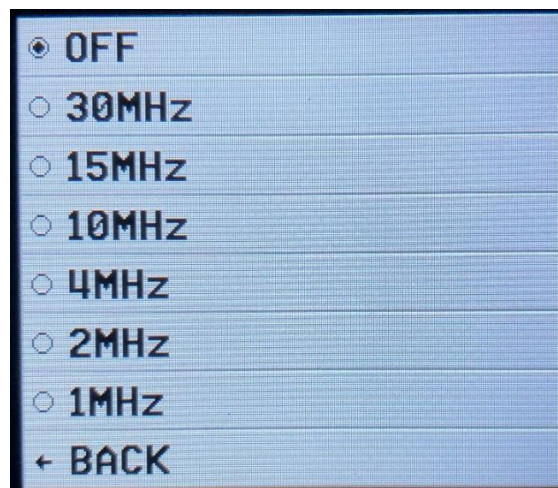


Figure 27

SELF TEST should be performed when using TinySA for the first time, to establish that everything is as it should be. Connect the two SMA female connectors marked HIGH and LOW with an SMA male-male test cable. Click on the screen and select CONFIG in Figure 28 and then SELF TEST in Figure 29. 10 different tests must be passed without error.

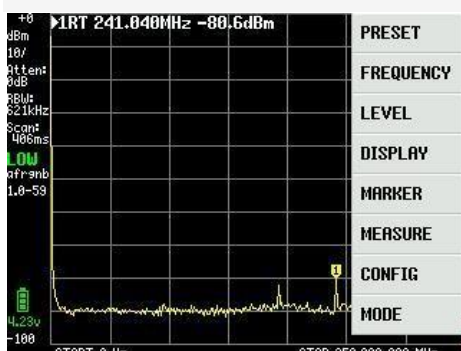


Figure 28

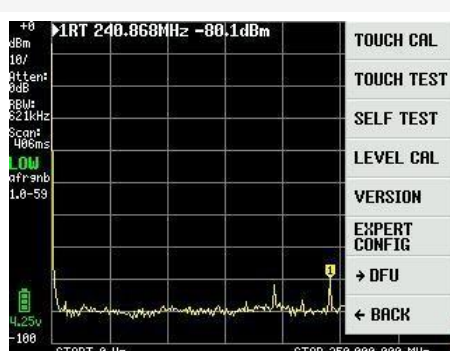


Figure 29

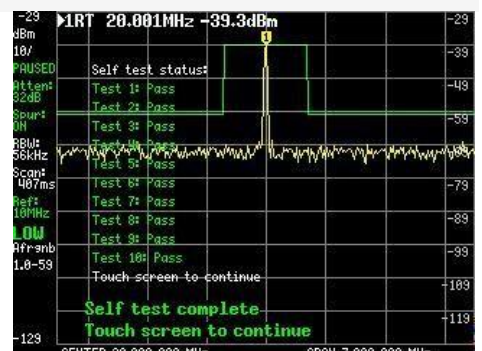


Figure 30

Calibration of TinySA signal level accuracy.

While HIGH and LOW still are connected to the test cable, select LEVEL CAL in Figure 29 and the following screen shot Figure 31 appears. Click on CALIBRATE and based on the measured level, here -25.7dBm shown in Figure 32, a complicated calculation is made for the entire frequency range, as TinySA contains a table of 10 frequencies that defines the filter curve for a 360MHz low-pass filter. A number of other data are included in this calibration, which results in an accuracy of about 1dB for the TinySA level measurements over the entire frequency range.



Figure 31

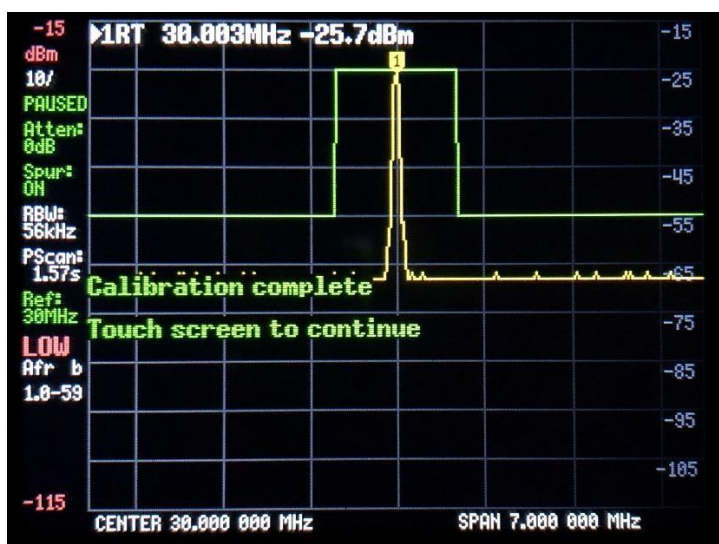


Figure 32

If you possess or have access to a signal generator with a very precise output level, there is another method that can be used which can provide the accuracy even better. The marker level readout is 0.1dB but there is a jump of 0.5dB between the different marker readings, which is due to the internal level detector itself having only 0.5 dB resolution.

Select CONFIG In Figure 33 then SWEEP SETTINGS In Figure 34 and finally select PRECISE in Figure 35 and go back

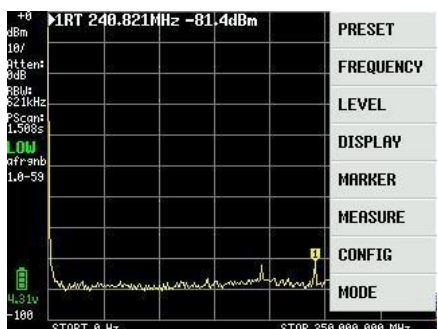


Figure 33

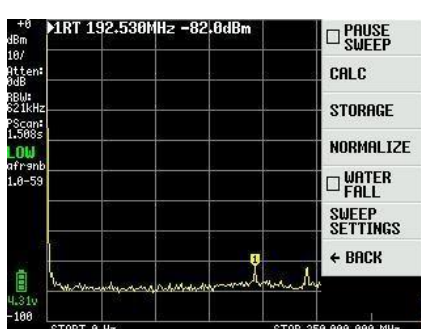


Figure 34

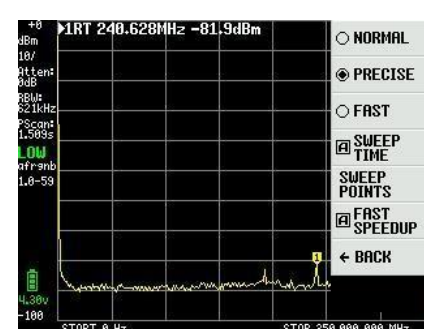


Figure 35

Next, select CONFIG I Figure 36 and EXPERT CONFIG I Figure 37 and finally ACTUAL POWER I Figure 38

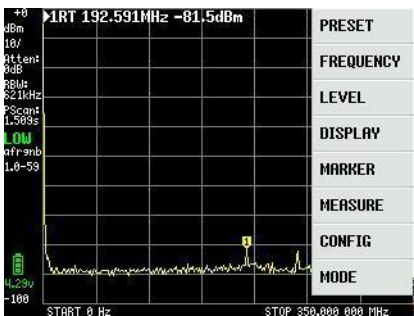


Figure 36

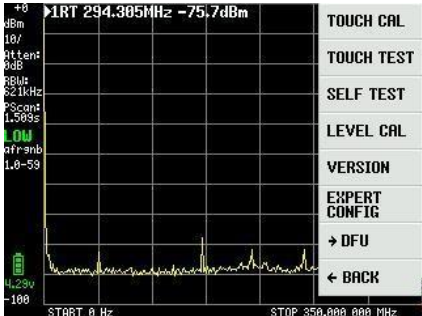


Figure 37

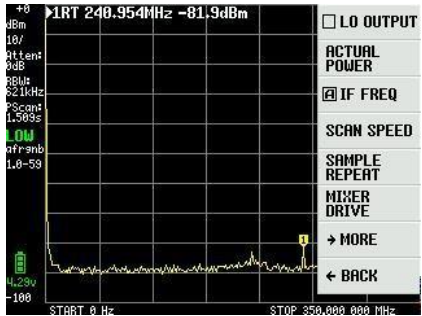


Figure 38

The level from the external signal generator that is supplied to input LOW, best in the range -20 to -30dBm, here in the example -20dBm, is entered in the field for ACTUAL POWER Figure 39. Frequency is optional but typically in the range 30 to 100MHz and here selection to 50MHz

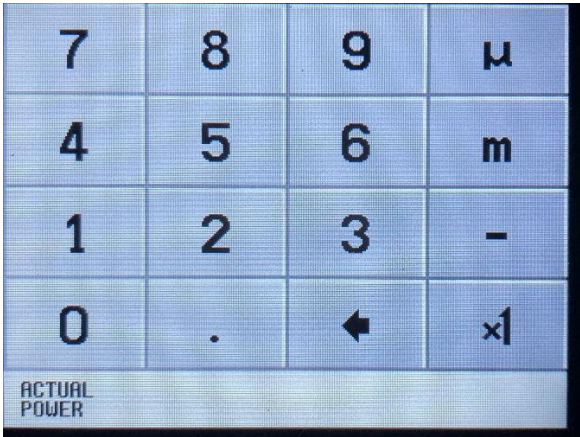


Figure 39

Successful calibration to the level -20dBm as shown in Figure 40. As can be seen, the noise floor is raised towards 350MHz as the increased loss of the low-pass filter at the band limit is compensated.

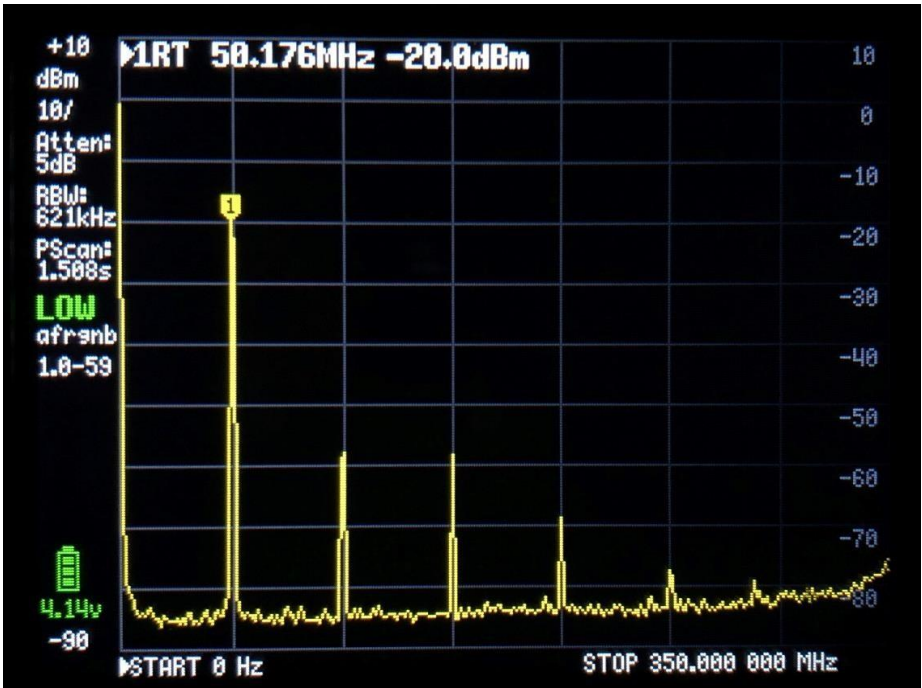


Figure 40

In the main menu that appears when you click on the screen, there is a menu item called MEASURE shown in Figure 41

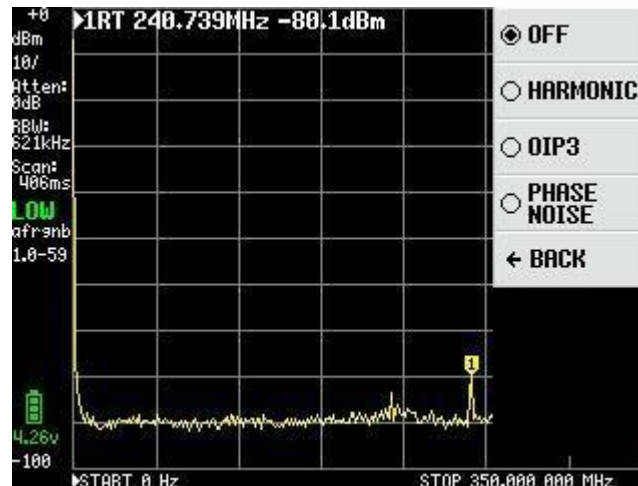


Figure 41

The signal used for calibration in Figure 40 comes from a very low noise HP signal generator, and if we first select the point HARMONIC, TinySA measures the harmonics as dBc, i.e. how many dB relative to the fundamental of 50 MHz. There are 4 markers available as shown in Figure 42

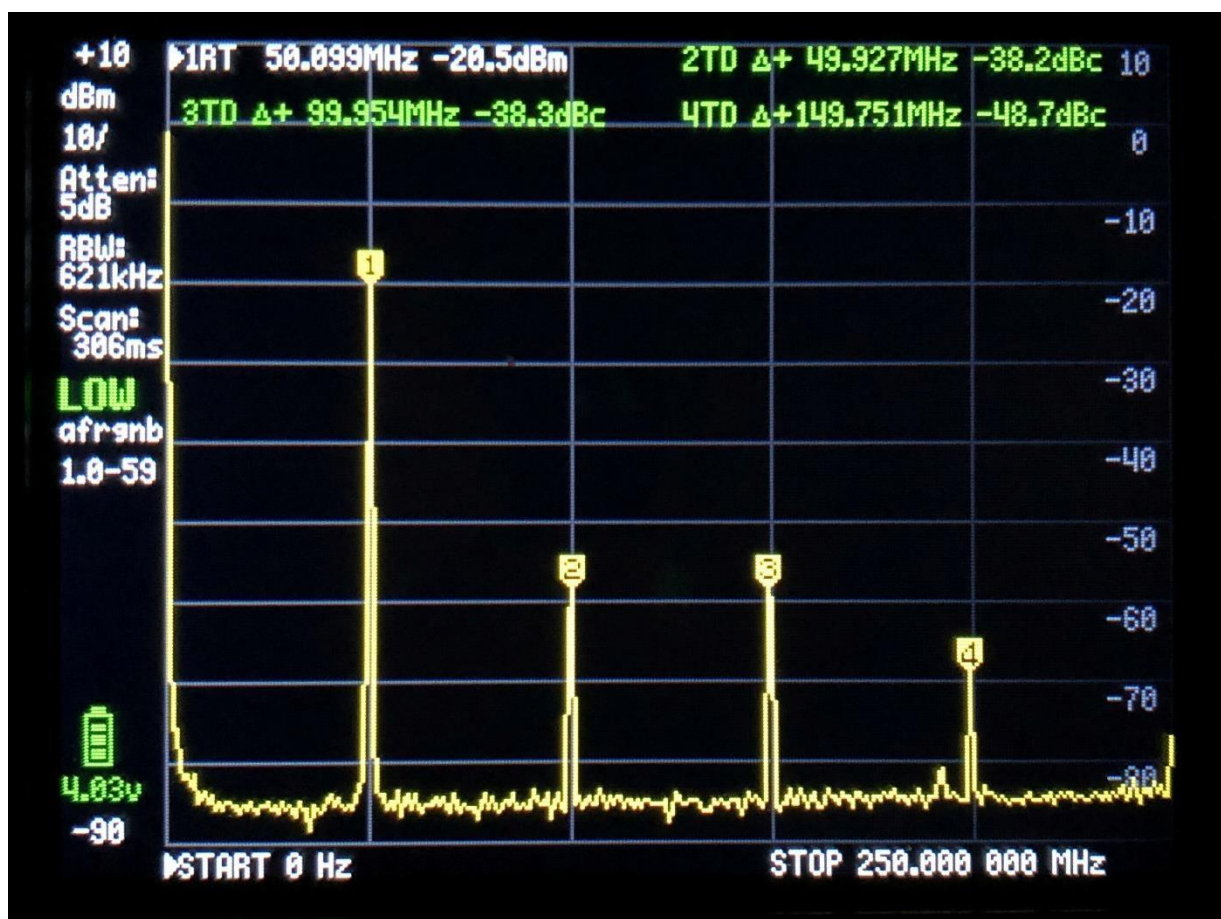


Figure 42

If you select PHASE NOISE in Figure, TinySA measures the phase noise in dBc / Hz converted to 1 Hz bandwidth for a given frequency distance. You specify the center frequency, here 50 MHz, and at what frequency distance you want the phase noise measured, here in the distance 2 MHz. The result is -123.7 dBc / Hz shown in Figure 43. Is it now the phase noise from the external generator or is it TinySA that generates the noise itself ??

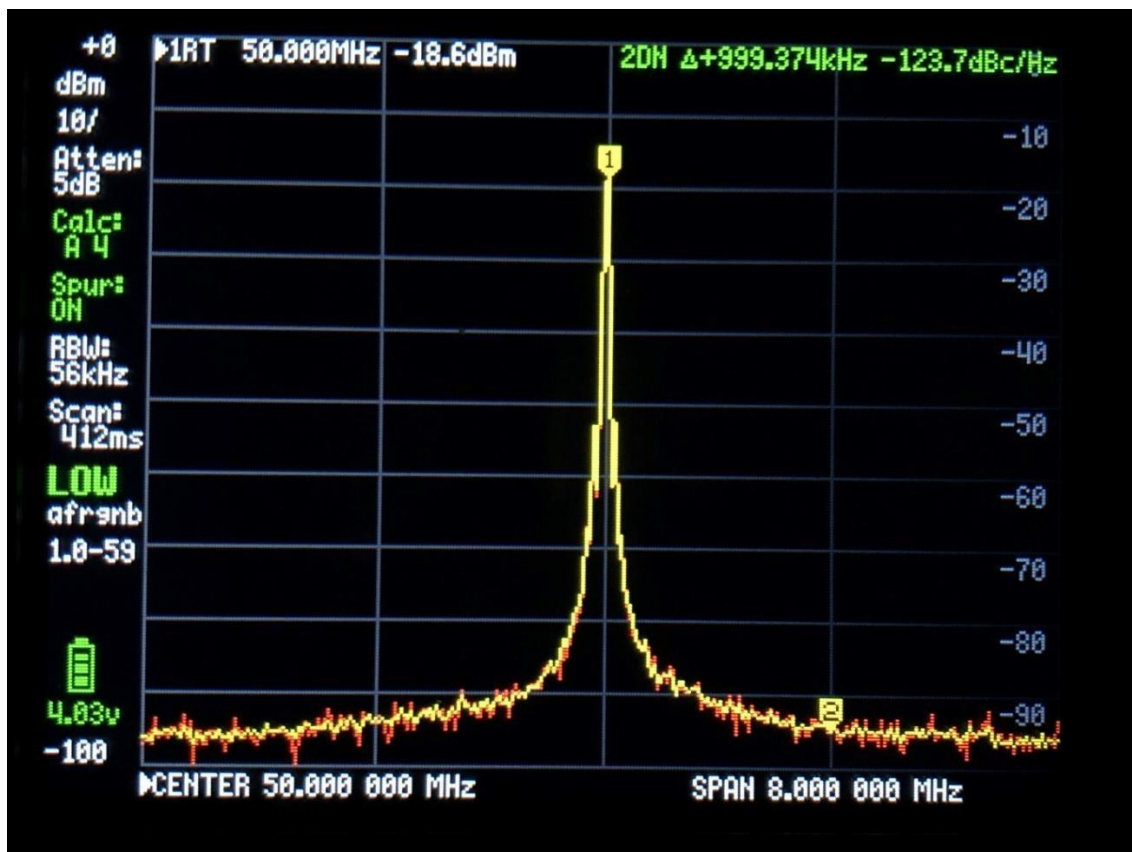
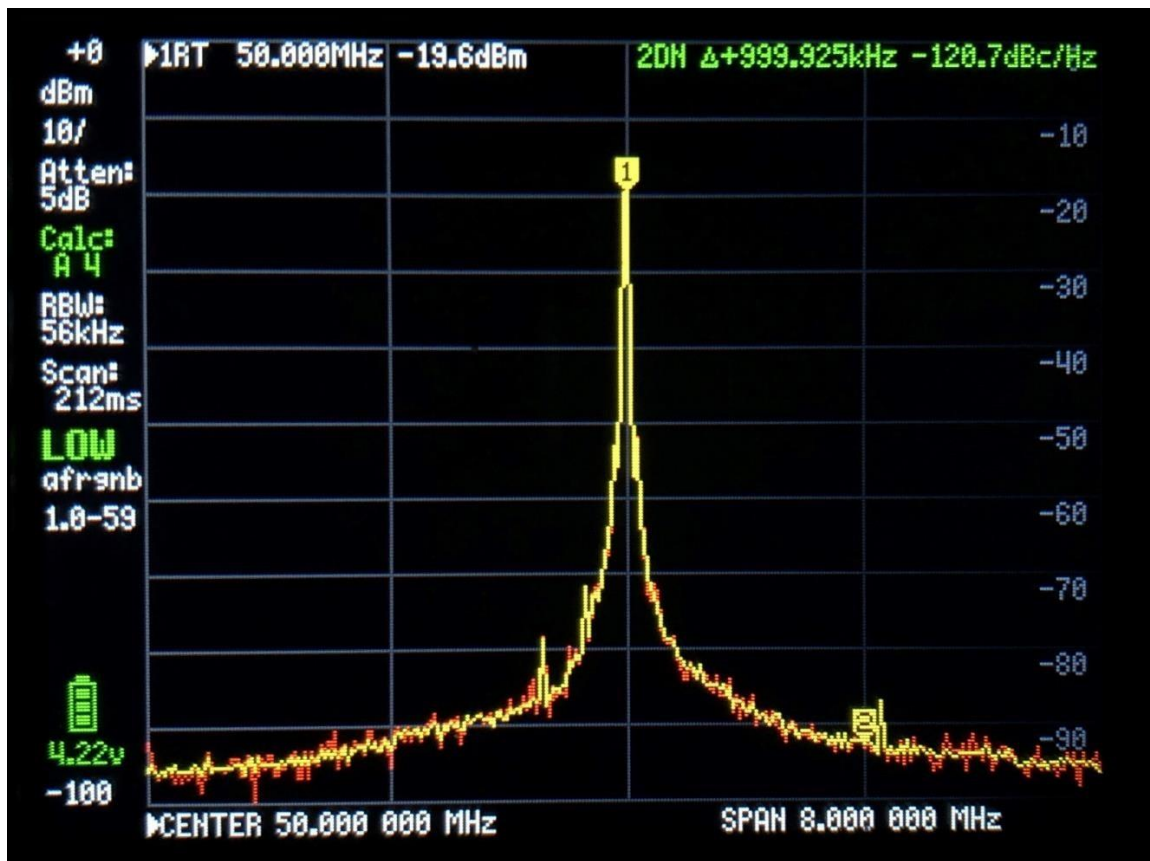


Figure 43

By delivering the same signal from another TinySA, a phase noise of 120.7 dBc/Hz is measured in Figure 44, which is exactly 3 dB lower, which in theory should also result, as they make the same amount of noise. The yellow track is a mean measurement and the red track is the current signal. Thus the noise is not generated by the HP generator.



Figur 44

The last thing you can measure in the MEASURE point is OIP3 or third order intermodulation. If an amplifier or a PA stage are applied to two signals f_1 and f_2 of the same amplitude, these signals will generate two new signals which are $2f_1 - f_2$ and $2f_2 - f_1$, which is called 3 order inter-modulation, and a measurement term for this is OIP3 which TinySA also can measure and calculate directly. These two new signals are in the frequency range f_1 minus f_2 above and below f_1 and f_2 , respectively. TinySA itself also has an IOP3 level, which is measured by supplying two signals from two measuring transmitters that do not in themselves generate an OIP3 value or a value that is several orders of magnitude better than TinySA itself. As a rule of thumb, $IOP3 = P_{out} + \Delta P/2$. Here are measurements on TinySA with two -4dBm signals applied at 50 and 55MHz and with intermodulation frequencies of 45 and 60MHz as shown in Figure 45. By reducing the input signals 10dB, the intermodulation products must decrease 20 dB which they also do in Figure 46 so TinySA IOP3 of 22.5dB resp 18.5dB is genuine enough.

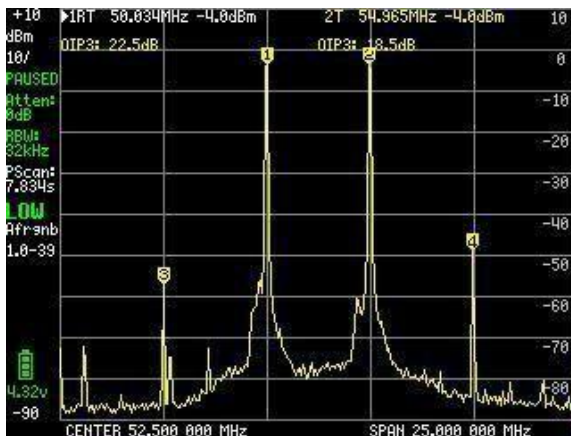


Figure 45



Figure 46

However, TinySA IOP3 can be improved by engaging an internal attenuator of 10dB whereby IOP3 increases to 31.5dB respectively 29.0dB as shown in Figure 47.

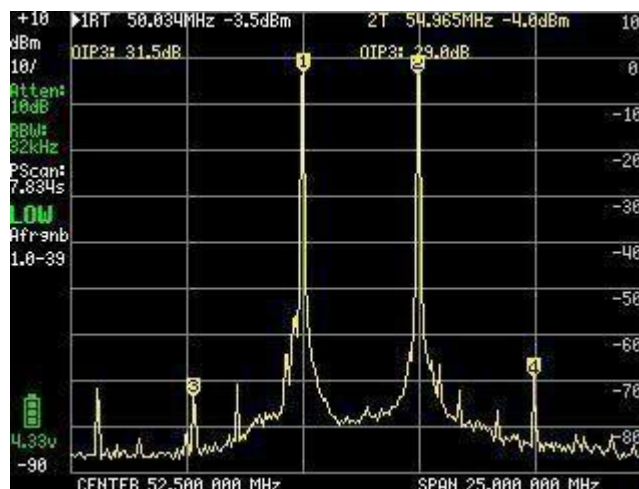


Figure 47

Since writing this document improvements made with added featured to the Menu Point MEASURE these are SNR for measuring SNR (signal to noise ratio), -6dB bandwidth, AM and FM for modulation monitoring of external signals applied to LOW or HIGH input.

Visit the Wiki page for further information

When selecting the main menu item FREQUENCY, there are settings for START and STOP frequencies or CENTER and SPAN frequency shown in Figure 48. There is also ZERO SPAN or CW and the input panel is as before shown with clear indication of what is being entered and in which frequency range that can be selected.



Figure 48

By selecting the point RBW Figure 49, the filter bandwidths can be selected as shown. There are a total of 6 available. When selecting Auto, TinySA calculates the optimal filter bandwidth, based on the selection of start and stop frequencies. At the same time, the optimal sweep time is calculated.

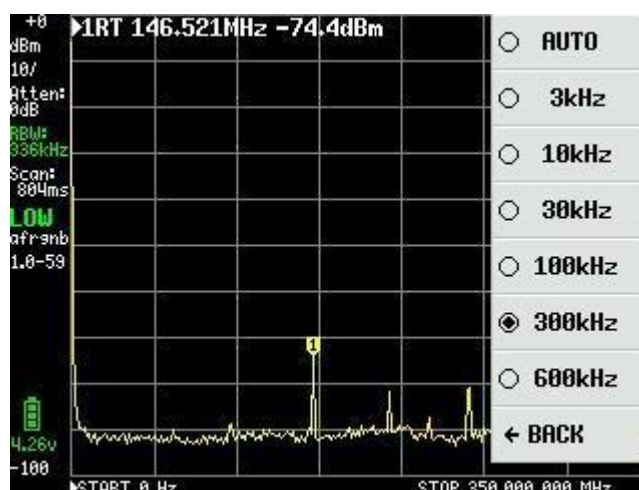


Figure 49

The last point under FREQUENCY Figure 48 is SPUR REMOVAL, which is an effective tool for removing spurious signals, except those that are directly harmonic of internal oscillators. However, this results in a slightly longer sweep time.

The next item in the main menu Figure 33 of Figure 36 is LEVEL and the options are shown in Figure 50

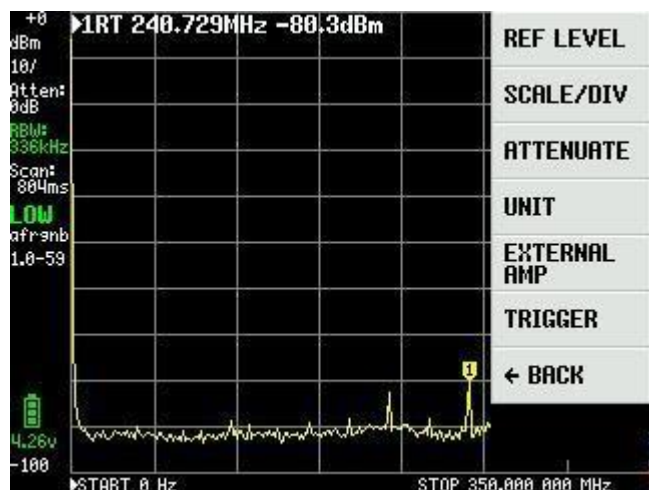


Figure 50

REF LEVEL in Figure 50 is the reference level as shown at the top left in Figure 51, here indicated as +0, and can either be automatically selected or set with MANUAL via the Input board Figure 52.

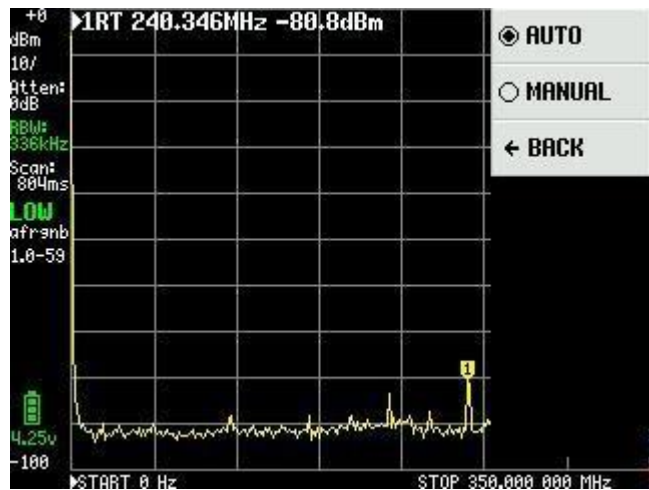


Figure 51

The range of both positive and negative values is largely unlimited, and there is a good reason for this, as in addition to the dBm unit, TinySA can also show the measured values in several other values, now good to be acquainted with so we are familiar with these by choosing UNIT in the main menu.

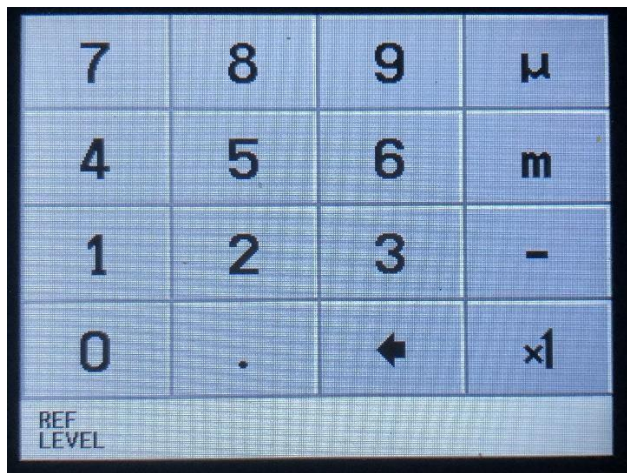


Figure 52

As shown in Figure 53, in addition to dBm, the measurements can be shown as dBmV, dBuV, Volt and Watt. These units descriptions can be seen in the Input board Figure 52

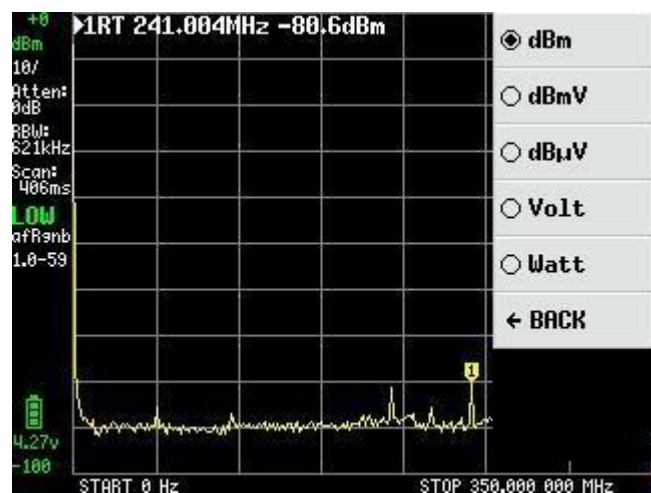


Figure 53

We return to the main menu by clicking on the screen and under the item LEVEL able to select SCALE / DIV. Here again an Input board appears as Figure 54 with the possibility to set the value for the scale division in the units dBm, dBmV, dBuV, Volt or Watt. Note that you can use the units m = milli, u = micro and n = nano.

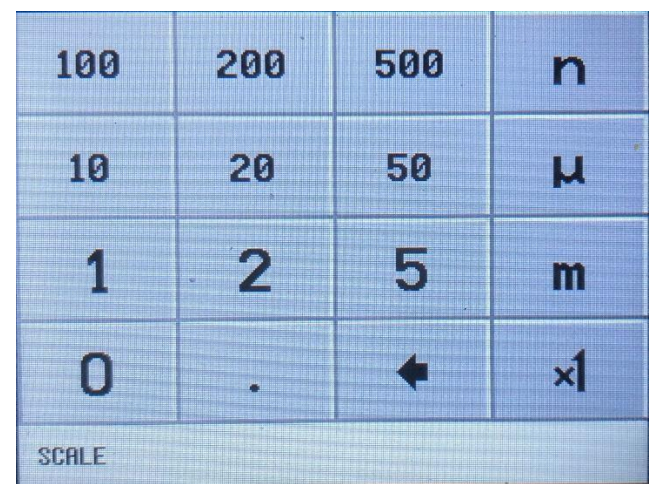


Figure 54

Still under the main menu and the item LEVEL as well as ATTENUATE it is possible to add internal attenuators. This can be done automatically by selecting AUTO or MANUAL in Figure 55

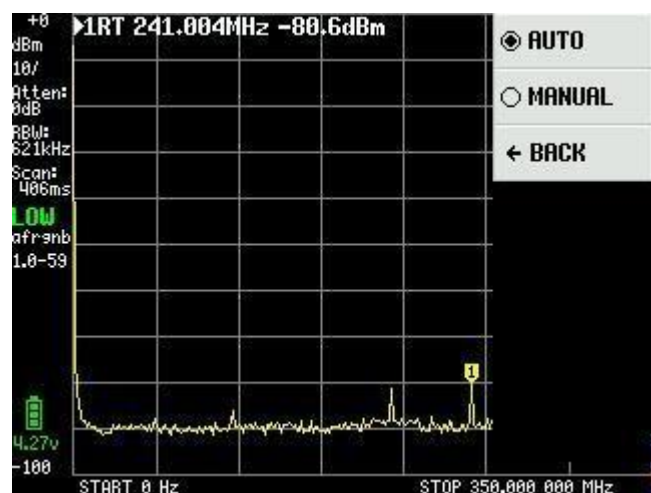


Figure 55

The attenuator value can be selected from 0 to 30dB with a resolution of 0.05dB up to 10dB and 0.1dB above and selected in Figure 56

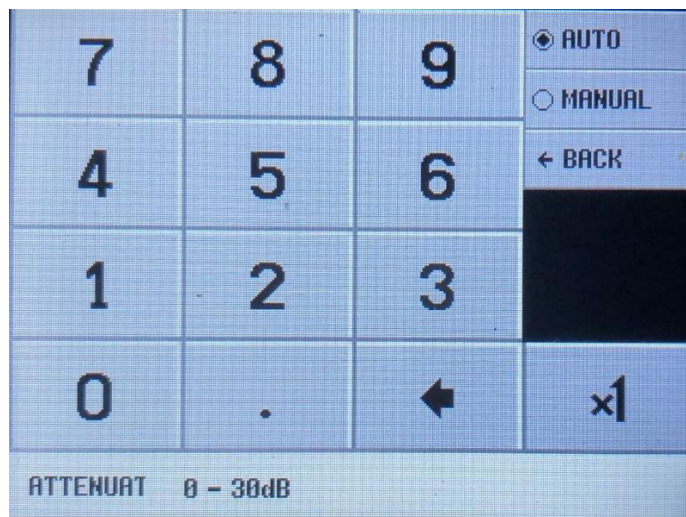


Figure 56

Still under the main menu and the item LEVEL, it is possible in Figure 50 with an EXTERNAL AMP to compensate for the amplification of the external amplifier with an OFFSET factor in dB e.g. -25 for an amplifier with 25dB gain entered in Figure 57. This amplifier must then have constant gain over the frequency range used for the measurement to be correct. If you need to search for noise sources, it is possible to measure all the way down to -135dBm with an 30dB amplifier added and 3KHz RBW

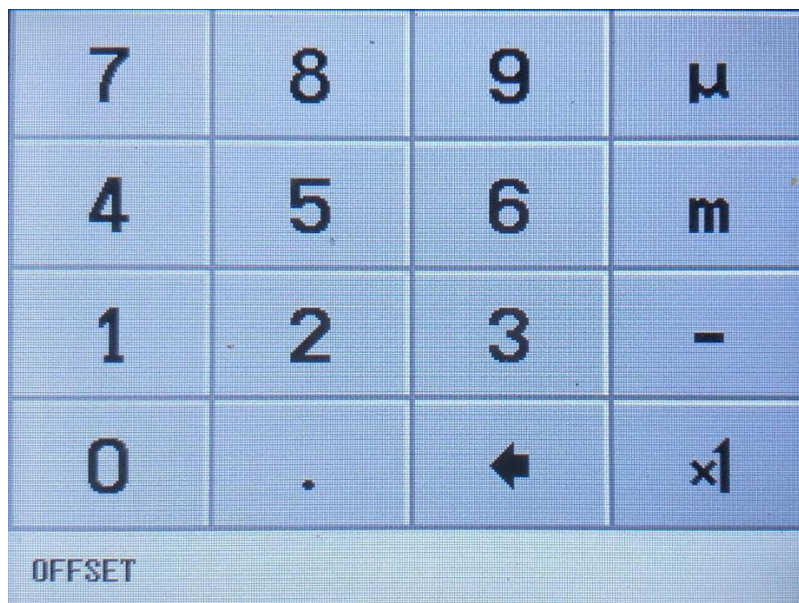


Figure 57

The last menu item in the LEVEL menu is TRIGGER Figure 58. Here you can select AUTO, NORMAL or SINGLE and whether to trigger positive edge UP EDGE or negative edge DOWN EDGE. Trigger Level is selected with TRIGGER LEVEL Figure 59. Depending on which UNIT is used, it is necessary to enter trigger levels with values in milli = m and micro = u

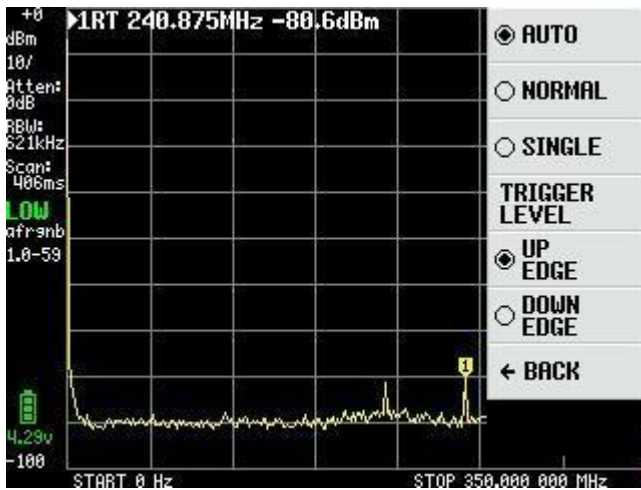


Figure 58

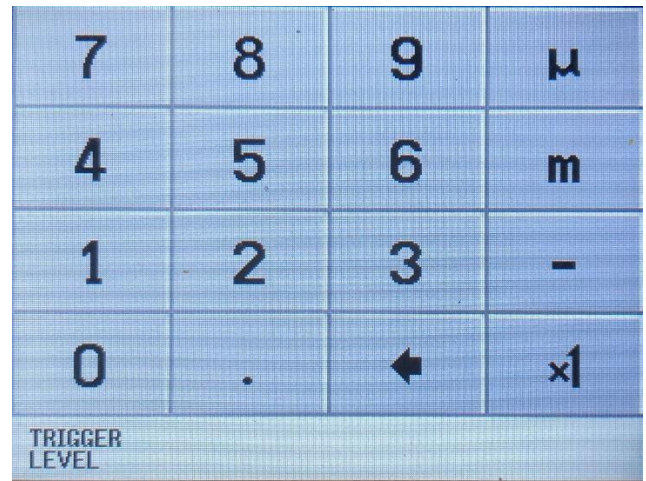


Figure 59

An example Figure 60 shows a signal from another tinySA frequency 10MHz Level -30dBm and AM modulation with 10Hz.

UNIT selected for Volt with REFERENCE LEVEL of 10mV, with 1 mV / DIV. TRIGGER LEVEL set to 6mV. TinySA only has + - 5 levels for the modulation so therefore this curve shape.



Figure 60

We have now seen what is hidden under the items FREQUENCY, LEVEL, MEASURE and A little under CONFIG. So now the focus will be the DISPLAY submenu which is selected in the Main Menu Figure 61

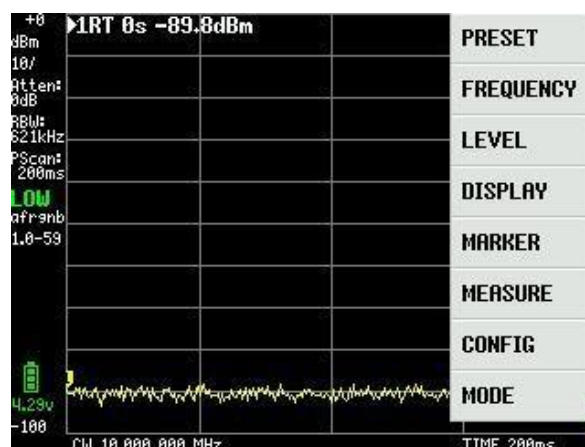


Figure 61

DISPLAY menu Figure 62 contains many exciting features where the first PAUSE SWEEP is self-explanatory



Figure 62

CALC menu Figure 63 you can choose over time with MAX HOLD and MIN HOLD to sum up the maximum respectively. minimum the values of a series of sweep.

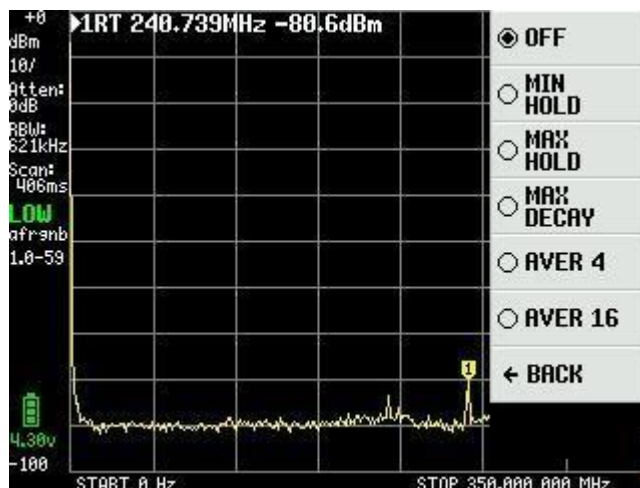


Figure 63

Figure 64 shows a situation where a short antenna connected to LOW input with MAX HOLD activated as the yellow trace where the red trace to the current trace after the antenna is removed. MAX DECAY causes the yellow MAX HOLD to slowly decrease in value if the signal disappears or becomes lower. AVER4 and AVER16 are averaging 4 consecutive 16 sweeps, respectively.

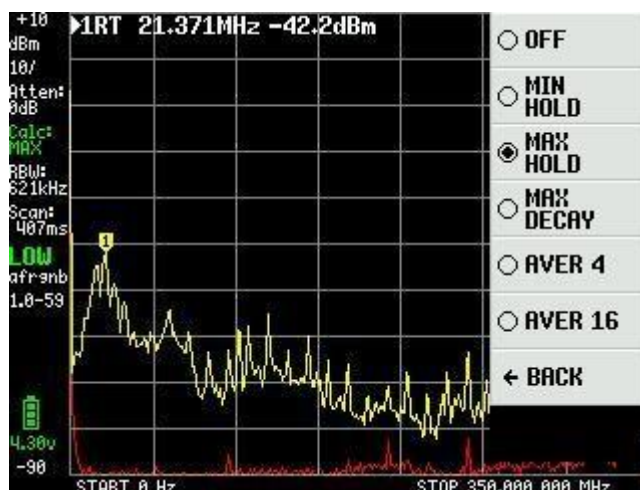


Figure 64

AVER16 selected in Figure 65 with 1dB for each division and is a function that can be used to pick up a weak signal from the noise.

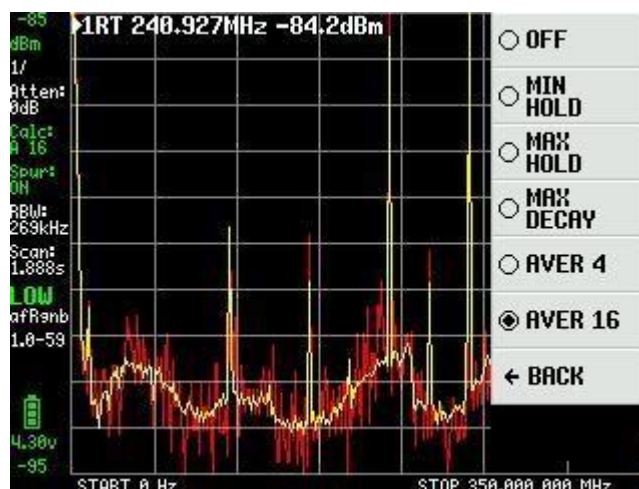


Figure 65

From the DISPLAY menu in Figure 62, there is STORAGE which, by clicking on STORE TRACE, stores the sweep. In the event of a repeated click, it is saved again. By clicking on SUBTRACT STORED from a yellow sweep around the 0dB line. In Figure 66, the input signal is reduced by 10dB as a demonstration that the difference between the stored and the current sweep is displayed in the yellow sweep.

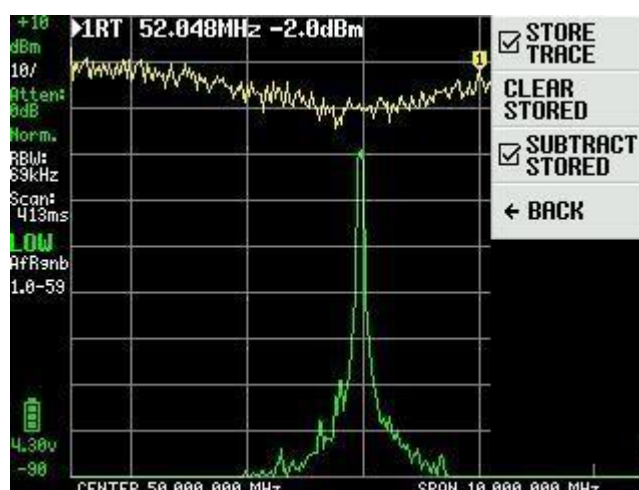


Figure 66

From the DISPLAY menu in Figure 62, NORMALIZE is the same as STORE TRACE and SUBTRACT TRACE without displaying the stored sweep. Here in Figure 67, the input signal is reduced from -20dBm to -50dBm after NORMALIZE is activated.

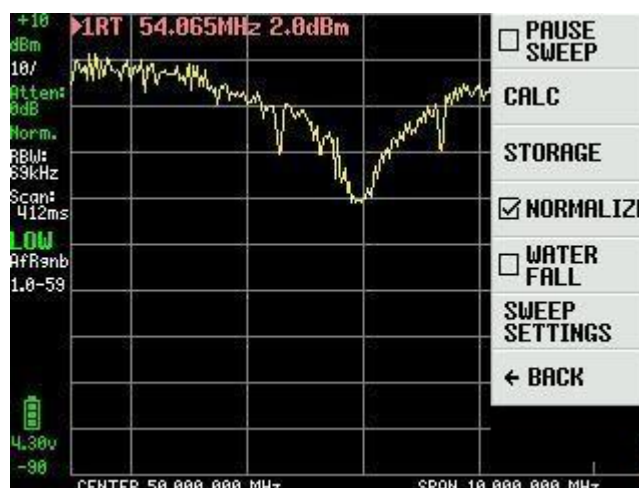


Figure 67

From the DISPLAY menu in Figure 62, WATERFALL Figure 68 is an interesting feature. You can choose to connect TinySA to an intermediate frequency output on a transceiver or directly to an antenna, and see if there is any traffic. The function can be combined with CALC and MAX DECAF. Latest Firmware allow choice of large or small waterfall

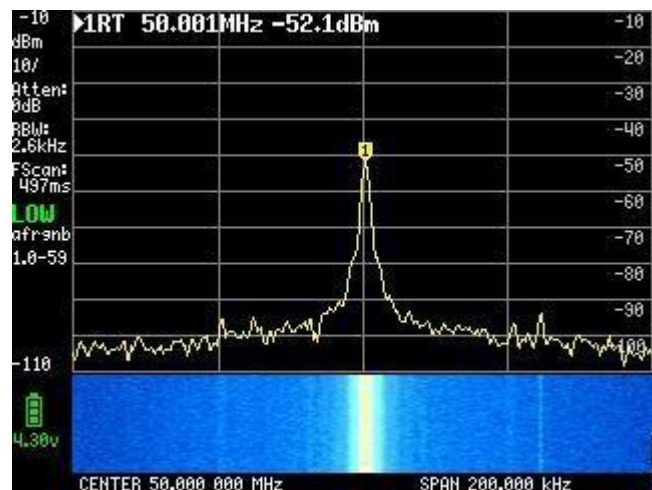


Figure 68

The last menu item from the DISPLAY menu in Figure 62 is Sweep settings Figure 69. As seen on the left side, a full sweep for the entire frequency range takes 406ms with a NORMAL and automatically selected sweep setting. However, we can change that. With PRECISE measured with greater accuracy, it takes 1,509 seconds due to greater accuracy. With FAST selected, a sweep takes 316ms. With FAST SPEEDUP figure 70 and a factor of 20, the sweep time is reduced to 274mS

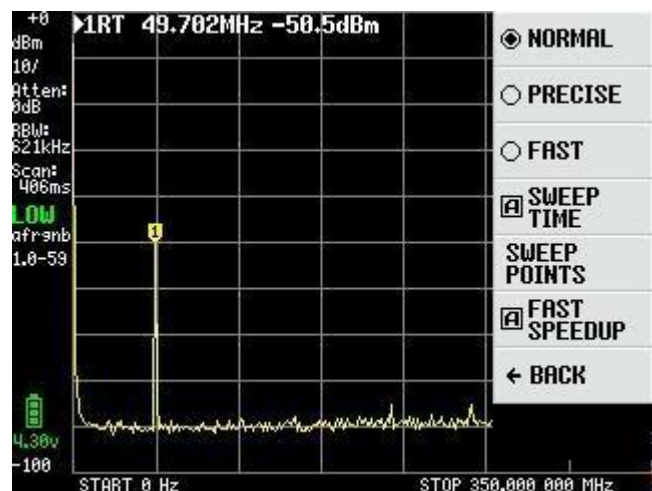


Figure 69

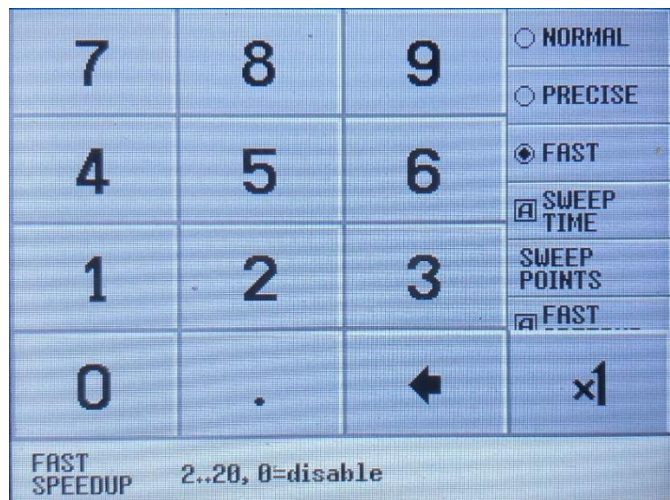


Figure 70

SWEEP TIME Figure 71 can be set up to 600 seconds and is independent of the other settings NORMAL, PRECISE, FAST and FAST SPEEDUP which will remain active if selected.

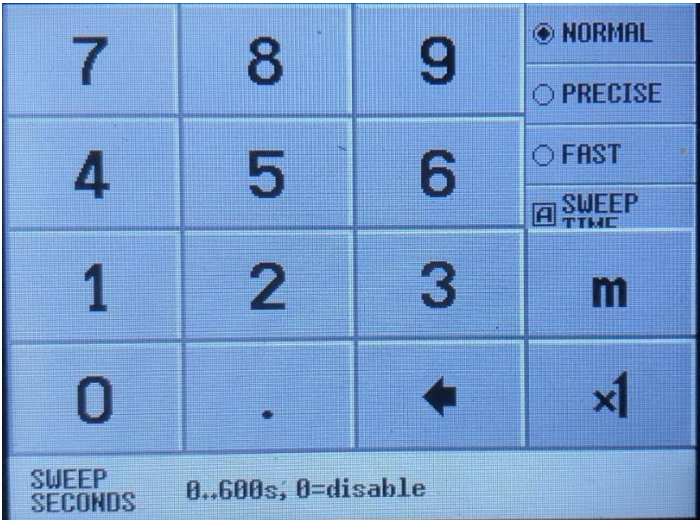


Figure 71

The last menu item under SWEEP SETTINGS is SWEEP POINTS figure 72. If 51 points are selected and all settings are about the fastest possible sweep then you can get down to 272ms and it is not less than with 290 points

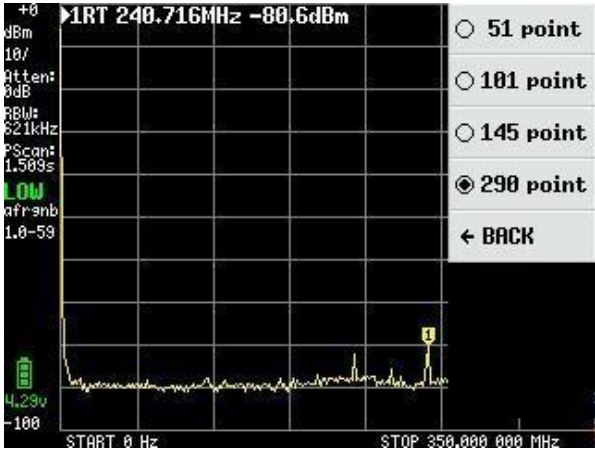


Figure 72

Until now, most screenshots have been with just 1 text line for marker data. We have seen that there can be up to 4 markers and they are selected in the DISPLAY menu Figure 61 MARKS as Figure 73

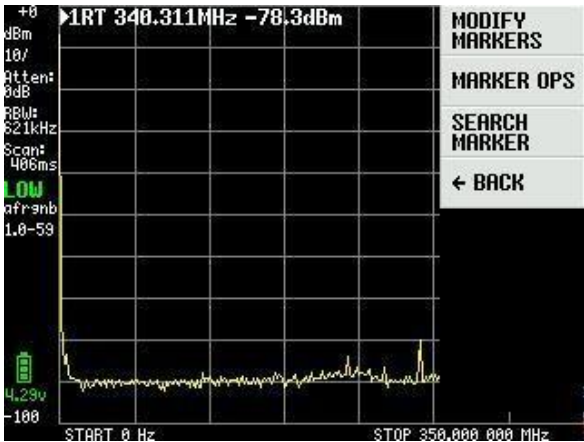


Figure 73

When selecting MODIFY MARKERS in Figure 73, a new selection menu appears Figure 74 which is also used to activate the four markers

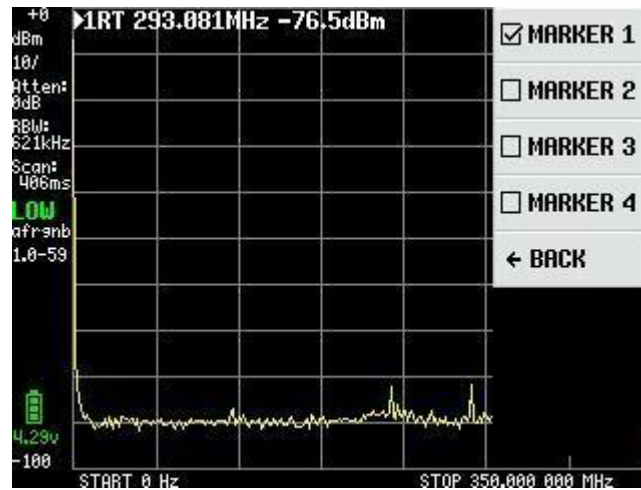


Figure 74

The settings for the 4 markers in Figure 75 are the same. Marker 1 is as standard REFER = reference marker and at the same time selected as a TRACKING marker that always finds the strongest signal in a sweep. If it changes to one NORMAL Marker can be moved with the rocker switch on the cabinet or by dragging it on the screen with the included tool or stylus. Signals shown are Cal.output from HIGH output from another TinySA with -20dB level.

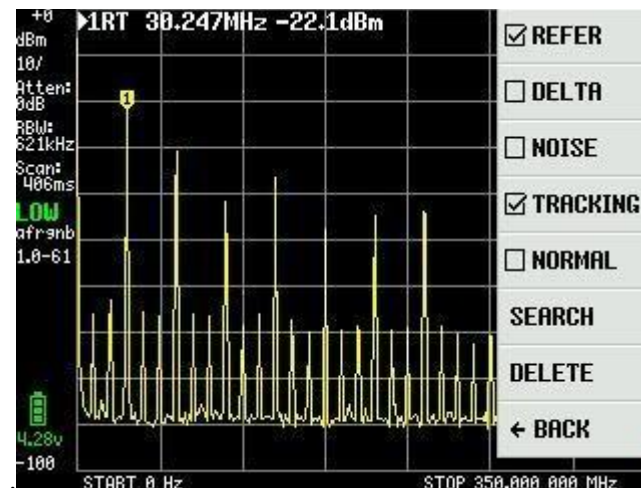


Figure 75

If the other three markers are activated as TRACKING and DELTA, Figure 76 shows these three markers as dBc relative marker 1 and sorted with increasing difference and shows the frequencies associated with the marker

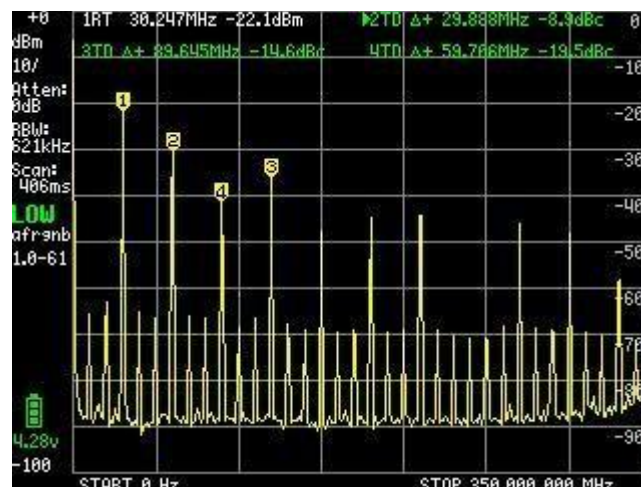


Figure 76

If field 3 is changed to NOISE field, you can move field 3 with the tilt switch and measure the noise floor as shown in Figure 77 to -146.6dBm / Hz

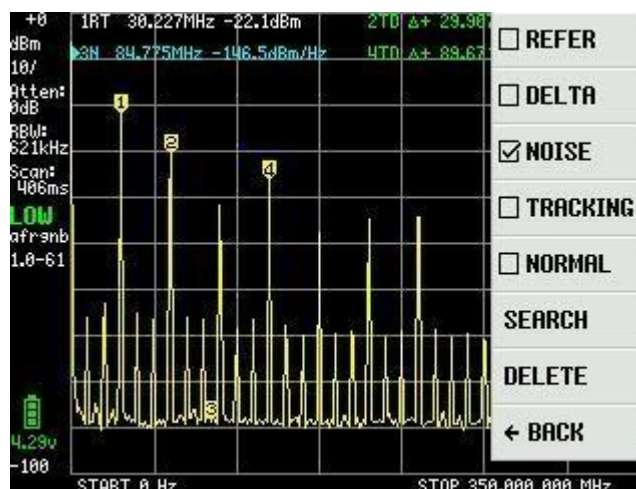


Figure 77

The SEARCH function is also an elegant feature. If field 3 is changed to NORMAL then you will repeatedly press for example. MAX -> RIGHT find all the maximum signals one by one, as shown in Figure 78. Even the small signals will be found. PEAK SEARCH finds the most powerful signal but requires that you do not have 0Hz as the starting frequency but e.g. 1MHz

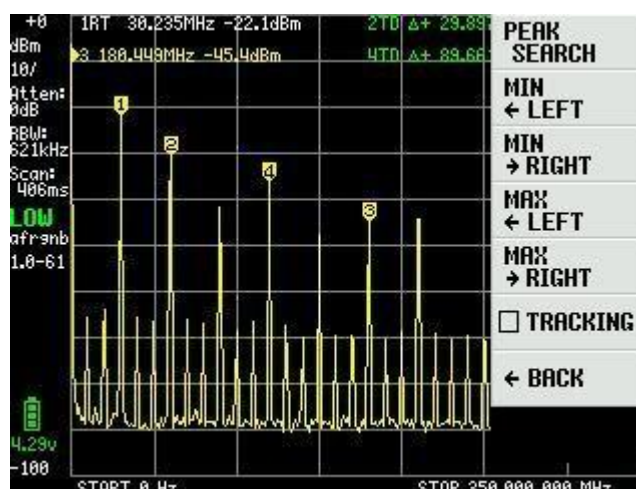


Figure 78

There is another marker function called MARKER OPS which is a bit tricky to understand and use. No screenshots will be shown but only explanations given about these four "inventions" Erik Kaashoek has introduced.

-> START - The frequency of the active field is made the start frequency of the screen. If the active marker is a tracking marker then it is moved to the start frequency of the screen and the tracking marker is the highest signal on the right.

-> STOP - The frequency of the active field is made the stop frequency of the screen. In the tracking marker, the highest signal to the left of the stop frequency is found.

-> CENTER - The frequency of the active field is made to the center frequency of the screen. To zoom in or out, use the Frequency and Span function.

-> SPAN - The center frequency retains but the span changes to the frequency difference between the active field and the center frequency. If there are two active tracking markers, then the frequencies of these two markers are made to the screen start and stop frequency.

PRESET function which can be selected from the main menu Figure 61 is shown in Figure 79 and when selecting LOAD STARTUP it corresponds to the setting that appears when you switch on TinySA, as a default setting. The four LOAD 1 to 4 if selected are retrieving settings saved with the STORE 1 to 4 function.



Figure 79

Figure 80 shows the setting retrieved with LOAD 1 that was previously saved with STORE 1. STORE AS STARTUP does not work yet for the default delivered firmware but now fixed by latest update of the frmware. The nimble reader probably sees that the firmware version from Figure 75 onwards is now 1.0-61. There is an ongoing update and 1.0-59 was only two days old during writing this document.

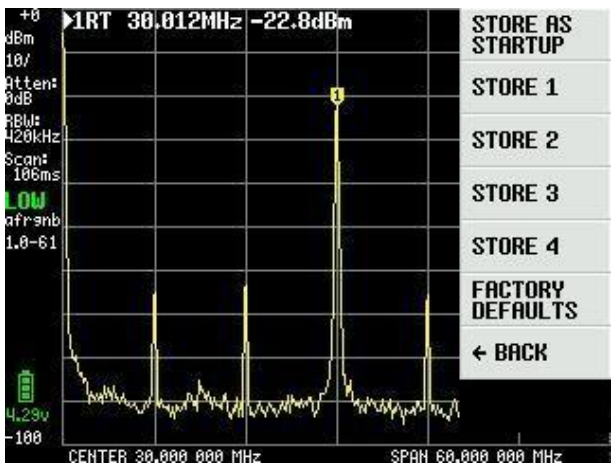


Figure 80

Description of TinySA is comprehensive and it is quite incredible what Erik Kaashoek has been able to introduce of smart features in this little wonder. Several version has been released and the improvements will continue.

The last menu item in the main menu Figure 61 is CONFIG as shown in Figure 81 when selected

TOUCH CAL is used to calibrate the touch screen by clicking in the upper left corner and lower right corner. TOUCH TEST allows you to draw doodles on the screen. SELF TEST is already described, also LEVEL CAL.

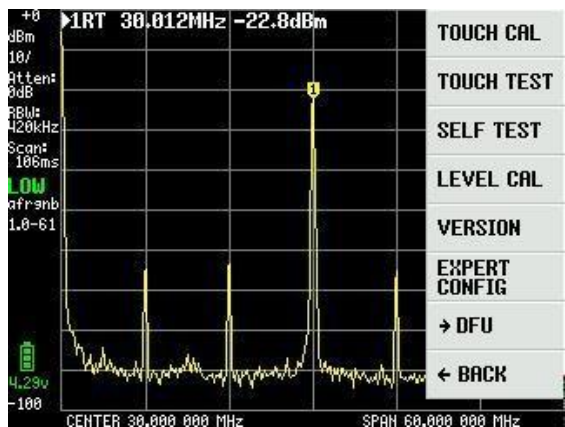


Figure 81

VERSION provides information about TinySA as shown in Figure 82

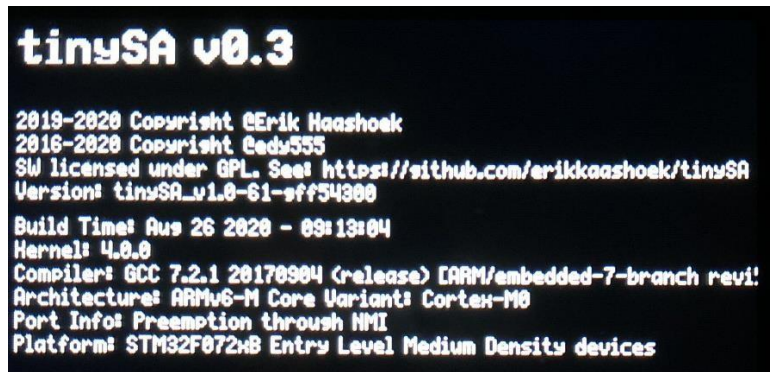


Figure 82

EXPERT CONFIG figure 83 contains advanced settings that are not normally used, but which the experimenter and experienced user can benefit from.

LO OUTPUT sends the first local oscillator to the HIGH OUT SMA connector, which can be used to make a tracking generator. LO is above the IF frequency

IF FREQ which by default is 433.8MHz can be changed within the range 433.6 to 434.3MHz, without significantly changing the sensitivity. Entry takes place in an input board and IF frequency is set to 0 for automatic selection of IF.

SCAN SPEED should not be used unless you know what you are dealing with, so please refer to <https://tinysa.org/wiki/> for further information.

SAMPLE REPEAT also has an input board where you can enter from 1 to 100, which means that each measuring point is repeated the selected number of times and the mean value is calculated.

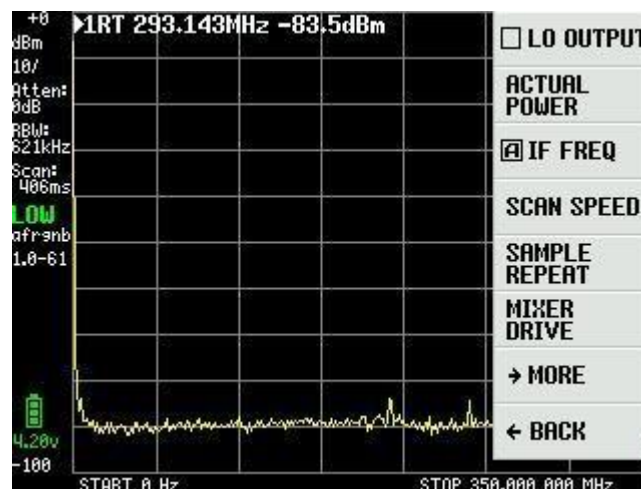


Figure 83

MIXER DRIVE selected in figure 83 allows to change the LO signal strength delivered to the mixer of Figure 84 shows the options + 7dBm is standard

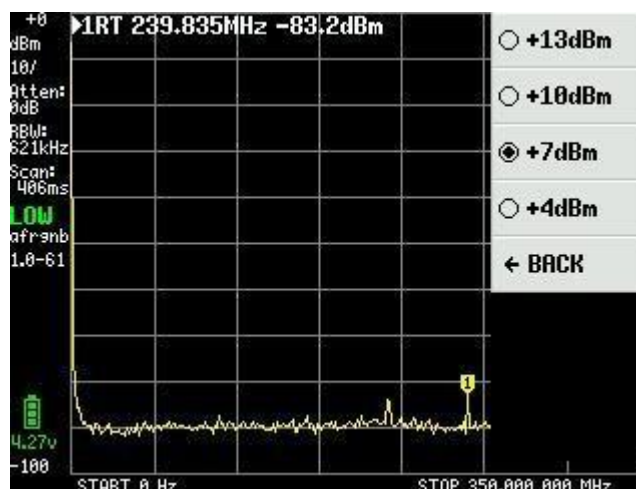


Figure 84

The MORE menu item in Figure 83 opens up even more settings and Figure 85 shows these.

By default, TinySA uses the AGC function, which constantly sets the reference level and selection of Attenuator values for an optimal screen image.

Likewise, LNA (low noise preamplifier) is active by default. Switching on and off is done by repeatedly clicking on AGC and LNA. When measuring in the low frequency range, it can be a good idea to disconnect the LNA and without AGC you have full control of all settings manually.

With BELOW IF, you change LO to be below IF for measurements below 190MHz.

HOLD SWEEPS also has an input board where the value from 1 to 1000 sweep can be entered, which determines how many sweeps must proceed before max values measured with MAX DECAY begin to fade out

NOISE LEVEL also has an input board where the values 2 to 20dB can be entered and indicates the expected noise band.

CORRECT FREQUENCY with its input board, allows to enter an accurate measurement of 10MHz Cal. the output signal measured on the HIGH SMA adapter. This improves the frequency measurements with TinySA

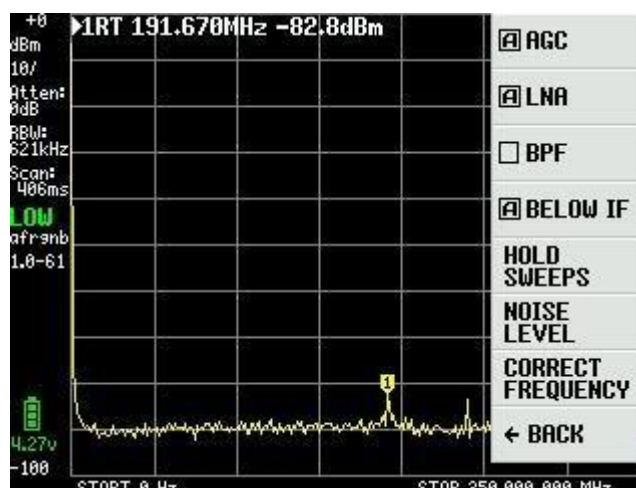


Figure 85

Selection of BPF in Figure 85 allows measurement of the internal 10MHz bandpass filter in TinySA. This requires that the HIGH and LOW SMA adapters be connected to a test cable. Figure 86 shows such a measurement.

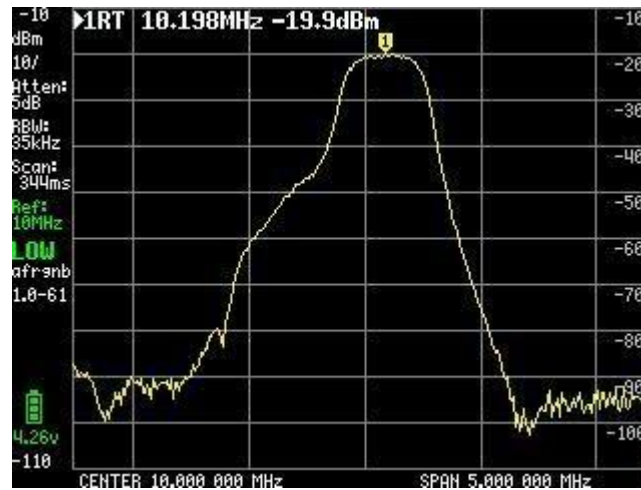


Figure 86

The last point in Figure 81 that needs to be described is DFU. Clicking ENTER DFU puts TinySA in a state where new firmware can be loaded.



Figure 87

The latest firmware is downloaded from <http://athome.kaashoek.com/tinySA/Windows/> which is also linked to on the Wiki page <https://tinysa.org/wiki/>. There are tools on the firmware link that can be used but it is recommended to use a tool that is very stable and easy to use is STM32 Cube Programmer. Search Google for STSW-STM32080.

The first thing to do is click on "Open file" and load the * .elf file you have downloaded shown in Figure 88

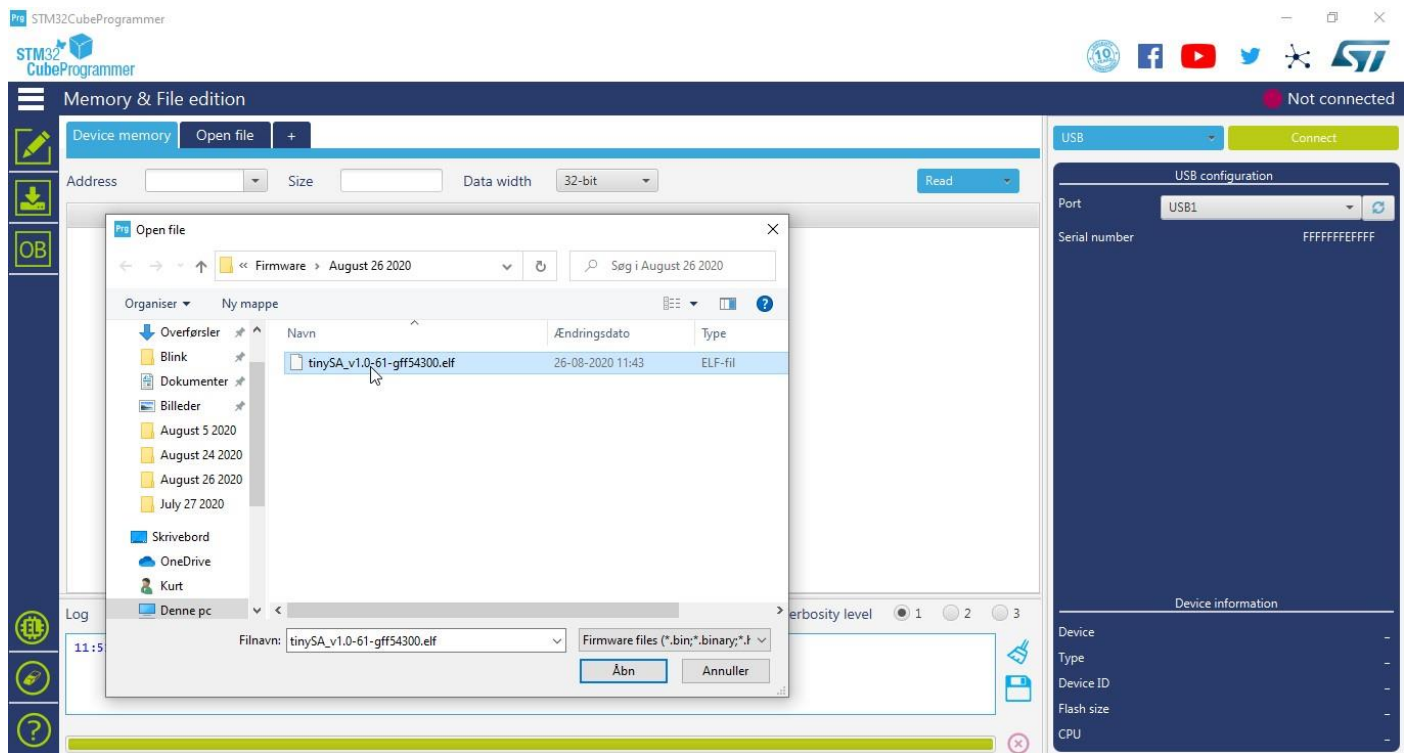


Figure 88

Then click on Download in Figure 89 and wait for the message "file download completed" and with a click on OK and Disconnect you turn off and on TinySA and then new firmware is installed.

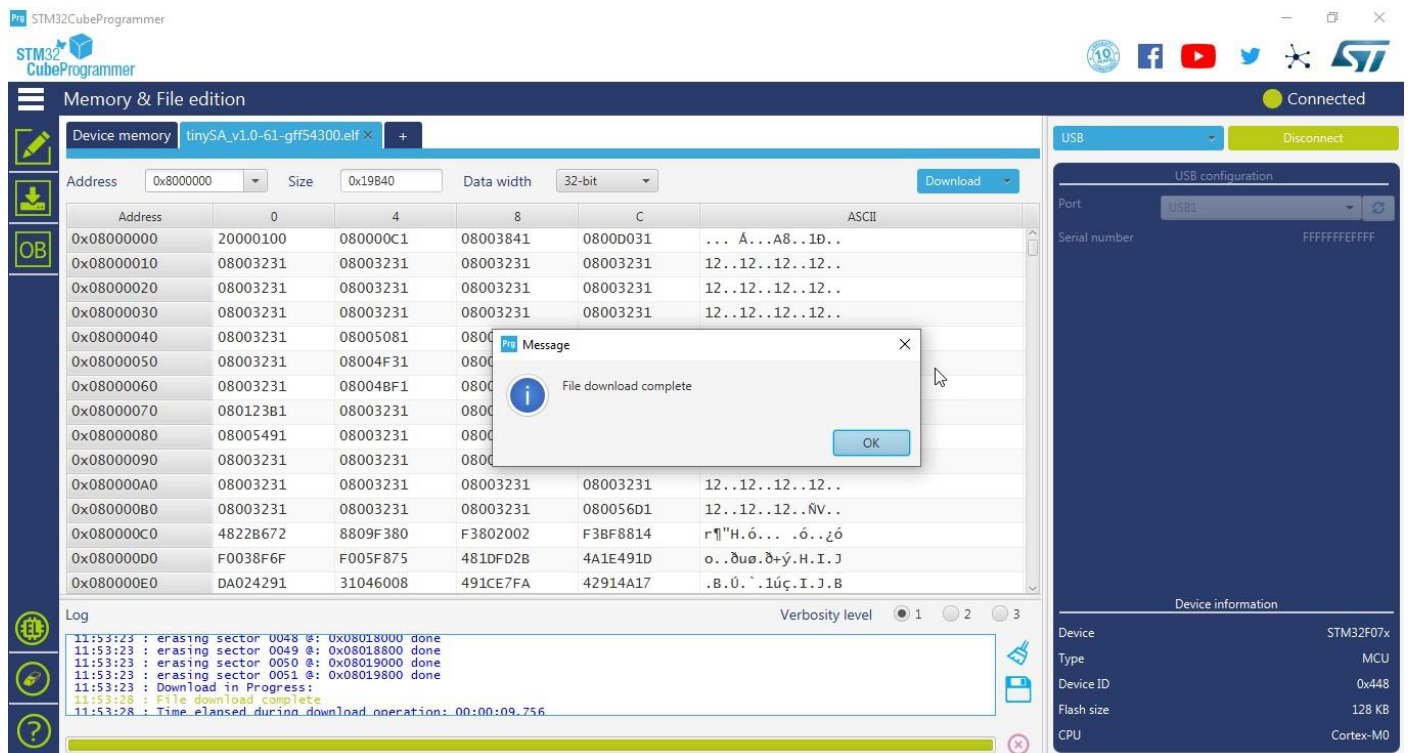
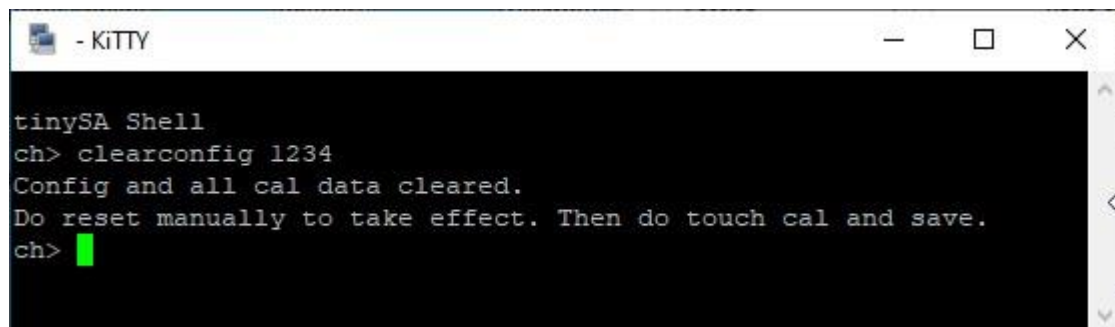


Figure 89

The other tools on the firmware page work with DFU files which can also be downloaded from the firmware page. Once new firmware is installed, it is necessary to send via the USB cable, a command to TinySA from a terminal program. This command is `clearconfig 1234` as shown in Figure 90. The speed is 9600bps and use Windows control panel as well as hardware properties to find which COM port TinySA is assigned. When this command is sent to tinySA, turn off and on for the changes to take effect. Next, TinySA sensitivity should be calibrated as described from Figure 29 through Figure 40.



```

KiTTY
tinySA Shell
ch> clearconfig 1234
Config and all cal data cleared.
Do reset manually to take effect. Then do touch cal and save.
ch>

```

Figure 90

A good terminal program is KiTTY which is an extended version of PuTTY. KiTTY has the advantage that you do not have to close the program when the black terminal window is closed.

As good news, there is also a PC program that can both take these screen dumps that have been shown in this description, but also control TinySA via the USB cable.

On the Wiki page there is a link to where the PC program is downloaded and the direct link is

<http://athome.kaashoek.com/tinySA/Windows/>

Figure 91 shows `tinySA.cfg` as well as `tinySA.exe`, both of which must be downloaded with a right-click of the mouse. There are all sorts of warnings that one should delete the file `tiySA.exe`, but keep it and the subsequent warning is also ignored. There have been complaints forwarded to Microsoft

Index of /tinySA/Windows

<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
 Parent Directory		-	
 USB tuned.jpg	2020-05-18 20:09	17K	
 USB untuned.jpg	2020-05-18 20:08	17K	
 USB wide.jpg	2020-05-18 20:11	18K	
 USB wide tuned.jpg	2020-05-18 20:12	18K	
 tinySA.cfg	2020-06-21 10:26	251	
 tinySA.exe	2020-08-11 12:57	139K	
 where_is_the_DFU_file.txt	2020-05-09 08:11	72	

Apache/2.4.10 (Debian) Server at athome.kaashoek.com Port 80

Figure 91

When starting the program Figure 92, the screenshot can be downloaded via the USB cable by clicking on the Capture Point

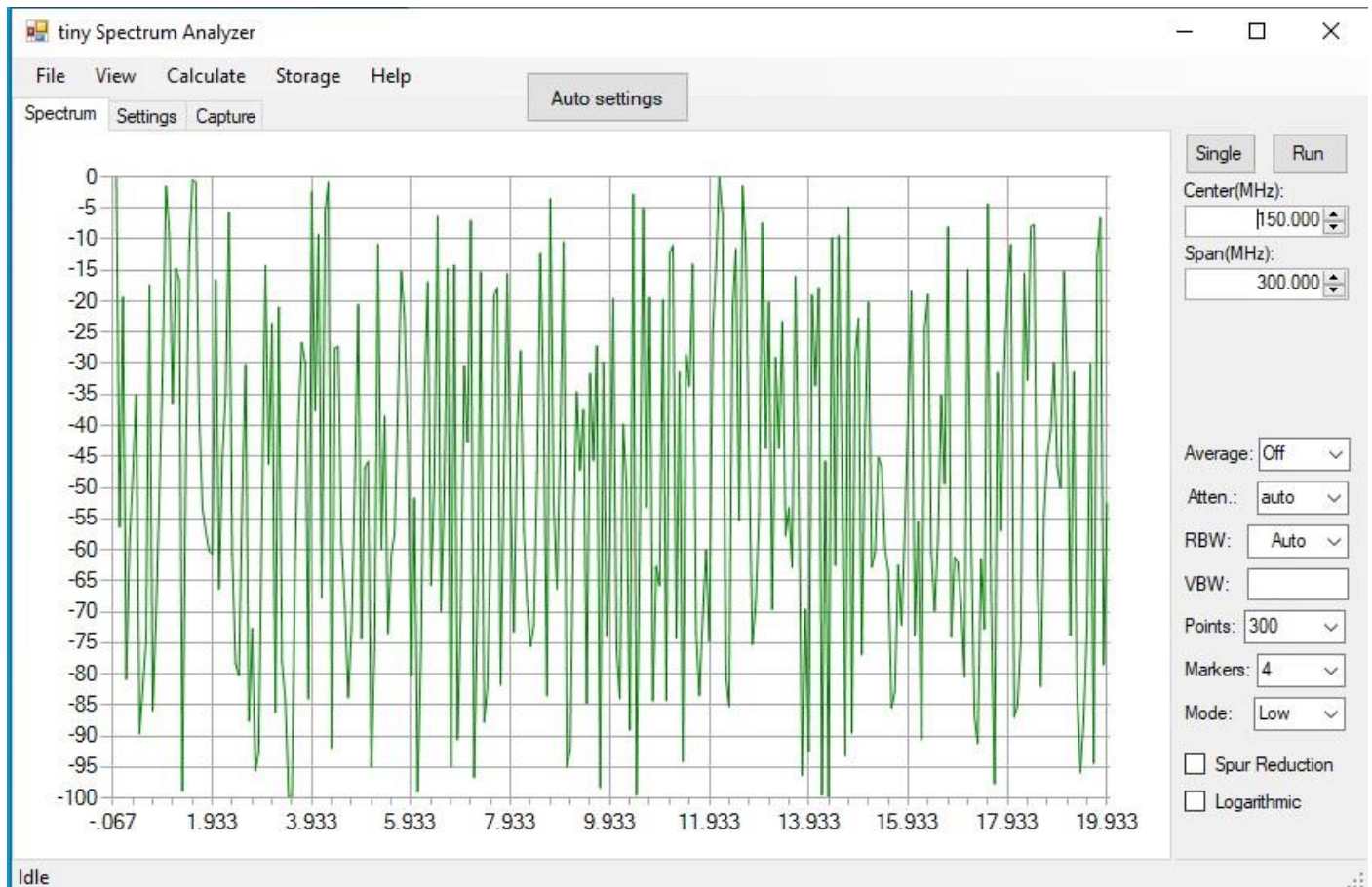


Figure 92

By clicking on Capture figure 93, screenshots are downloaded, after which by clicking on Save you can save it as a jpg, bmp or gif file.

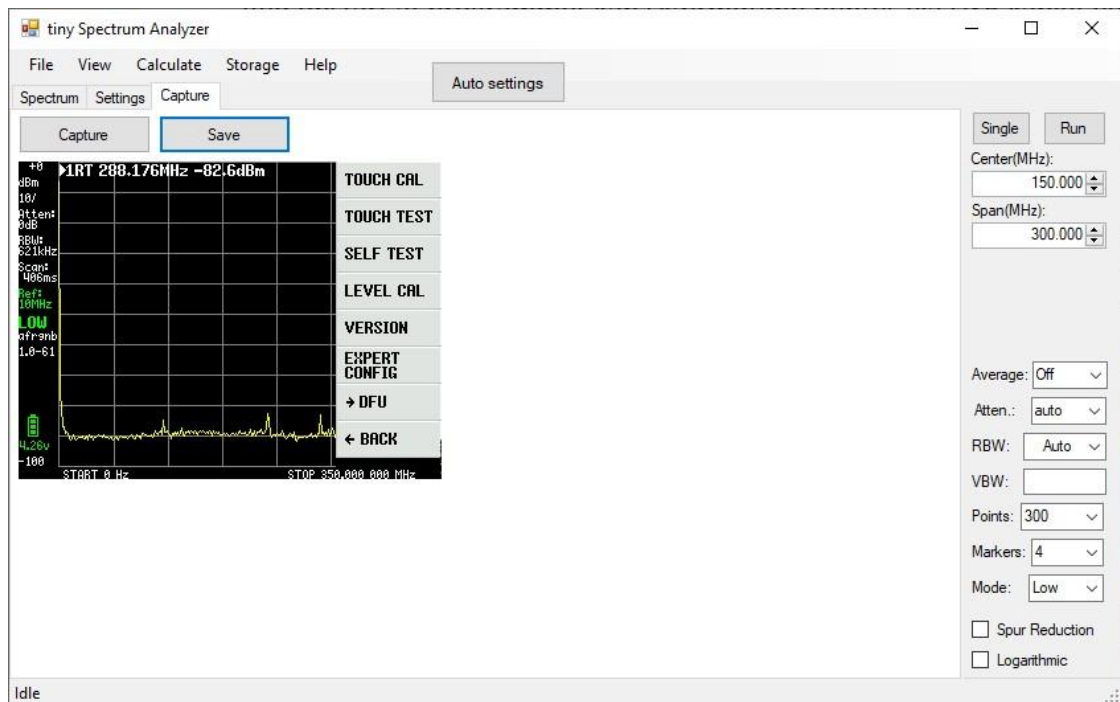


Figure 93

With appropriate programming of Center frequency and Span as well as selection of RBW from 3KHz to 600KHz or Auto. Number of points from 100 to 10000, Attenuator from 1 to 30dB or auto, Average from Off over Min Hold, Max Hold, 2,4,8,16 or 32 sweep, Markers from 0,1,2,4,8,16 to 32 then Figure 94 shows that there are many options for customizing measurements in much more detail than on the actual screen of TinySA.

With a Click on Calculate you can even measure Distortion as well as IOP3, MIN MAX and NORMALIZE to any dB value.

With Storage, there are several options for storing and retrieving as well as making Subtract

With View, it is possible to select both Delta frequency and Delta level markers

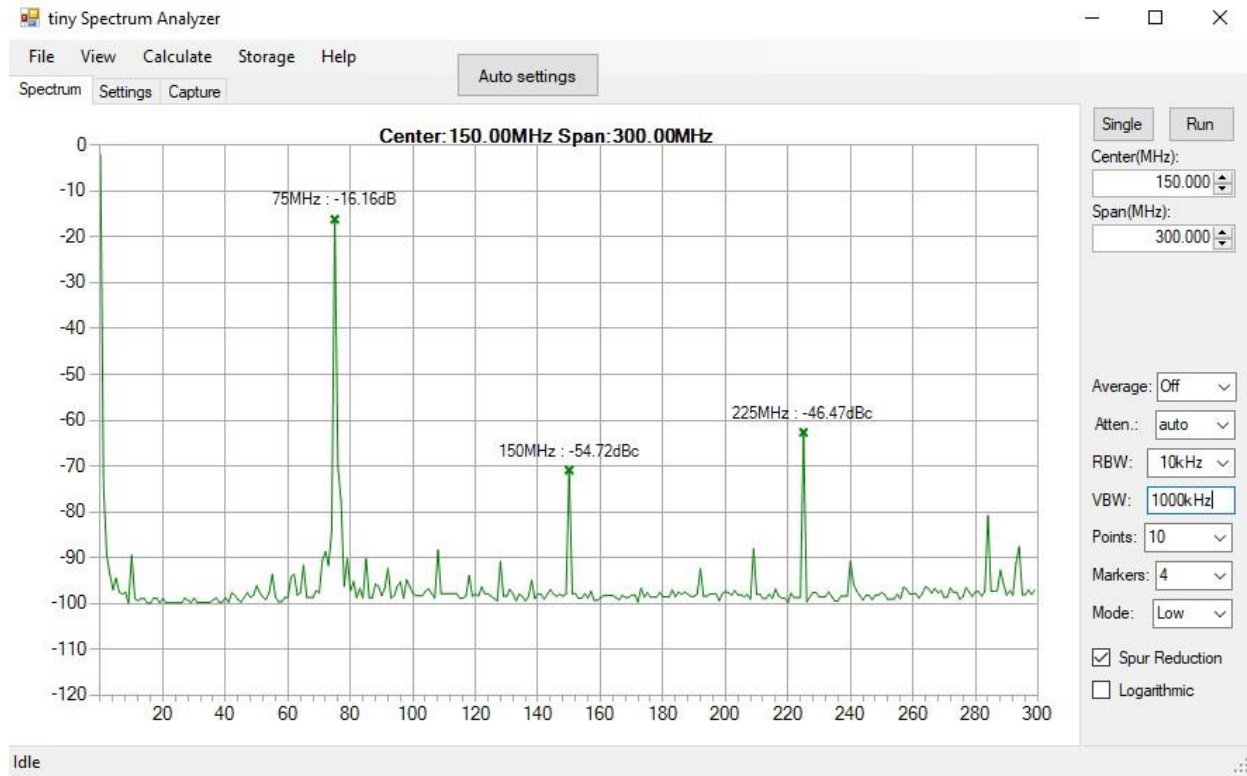


Figure 94

For the advanced user, there is a whole set of commands with which one can program TinySA via the terminal program. With the Help command, these are listed as shown in Figure 95

```
tinySA Shell
ch> help
Commands: version reset freq dac saveconfig clearconfig data
frequencies scan scanraw sweep test touchcal touchtest pause resume
trace trigger marker capture vbat vbat_offset help info color
if attenuate level sweeptime leveloffset levelchange modulation
rbw mode spur load output deviceid selftest correction threads
```

Figure 95

KiTTY is as I said an excellent Terminal program and the black screen terminal itself is started with a click on Start in Figure 96

The setup can tease a bit. Select Serial and find in Windows control panel and Hardware Settings which COM port is assigned to TinySA. Insert this in the Serial Line field, select the text Default Settings and click Save. Then this setting is remembered next and subsequent times KiTTY is started.

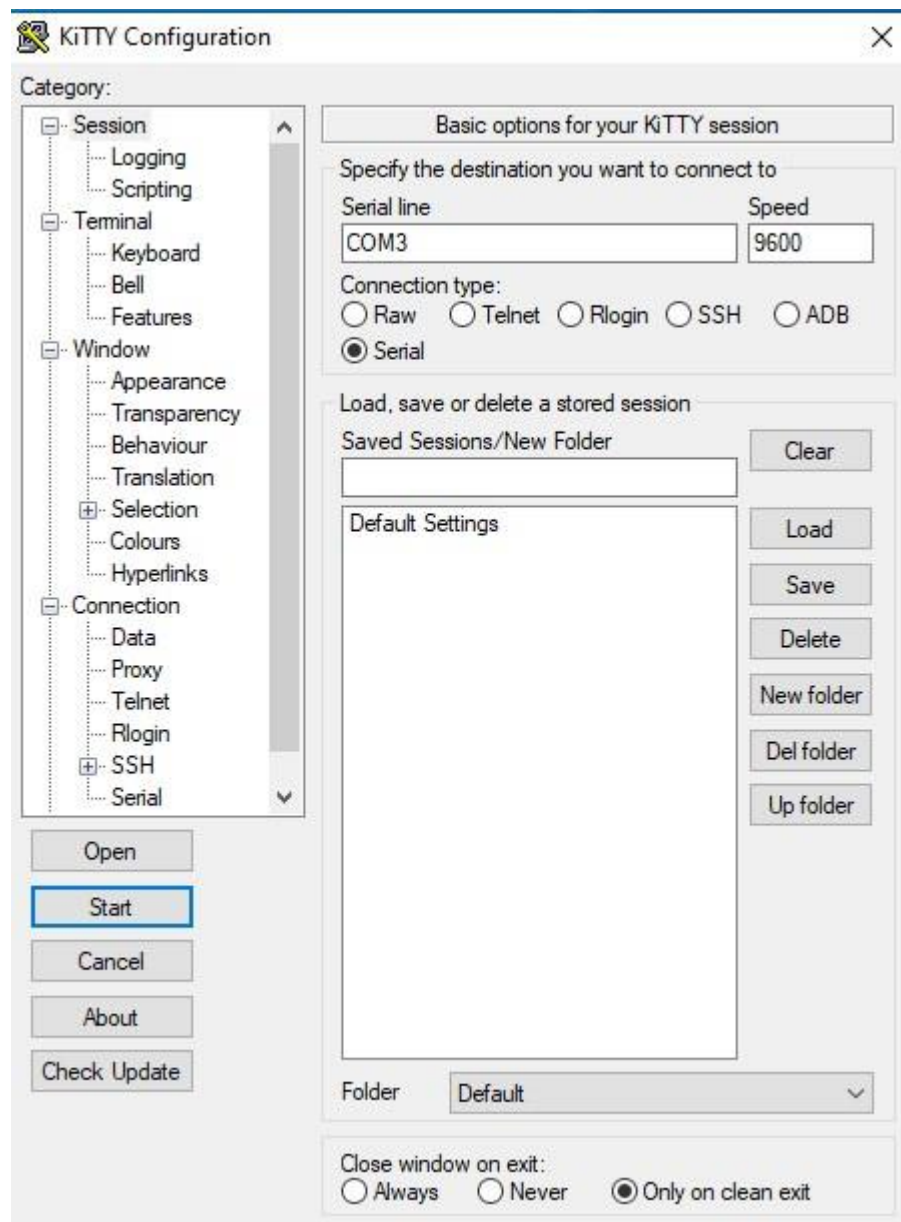


Figure 96