TinySA and Ultra User manual and programming guide

V1.6

TerryJin (Tianjin) Technology Co., Ltd

2024-10-17

Notice

Notes:

This product contains a lithium battery, so it needs to comply with the relevant laws and regulations of the country during storage and transportation.

Because this product is imitated by a small number of unscrupulous merchants, these unscrupulous merchants speculate on their reputation and do not optimize RF performance at all, so the company is not responsible for the maintenance and training services of products that are not sold by the company through Taobao or business-to-business.

Legal content:

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版本信息:

version	Written by	Updated content	Updated date
V1.0	Terry Kong	Initial release	2024-01-01
V1.1	Terry Kong	Added some programming content	2024-06-12
V1.2	Terry Kong	Modified the menu tree translation	2024-06-21
V1.3	Terry Kong	Added sensitivity test results	2024-07-08
V1.4	Terry Kong	Revised signal generator specifications	2024-08-27
V1.5	Terry Kong	Modified menu descriptions such as Spur Remove	2024-09-10
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The company's main business:

We provide customized miniaturized and efficient RF and microwave test equipment, RF modules, and firmware and software for testing. These RF products are mainly used to meet the basic testing needs of factories, scientific research institutions, radio amateurs, and student learning needs. The company adheres to the principle of free and open cooperation, mutual benefit, mutual learning, mutual progress, hoping to communicate with customers more professionally and more quickly, solve practical problems in the field of radio frequency, and strive to obtain the greatest economic input-output ratio for customers.

At the same time, the engineers of this studio are proficient in Keysight, Ruder Finn, Anritsu related RF instruments, provide maintenance, online training consultation, more information please contact Taobao directly or email.

At present, the main hardware products are:

TinySA, TinySA Ultra , NanoVNA , NanoVNA-H2 , NanoVNA-H4, NanoVNA SAA2 , LiteVNA , LibreVNA， NanoVNA-F V2， NanoVNA-F V3

The current software products mainly include:

TinySA and Ultra Firmware customized development, host computer App customized development. LiteVNA and LibreVNA host computer App customized development.

Video Tutorials:

You can search for the TinyRFEquip account on Bilibili and find videos introducing the main functions of TinySA and TinySA Ultra and other TinyRFEquip instruments on Bilibili website. For example:

TinySA Ultra is _bilibili for the verification and measurement of frequency characteristics of wireless microphones

https://www.bilibili.com/video/BV1yt421u7Y2/?vd_source=8d60a323bdde2d574cb0a85c07cb3212

Chinese Manual:

All relevant Chinese user manuals and programming instructions can be found and downloaded from the Baidu Netdisk link below

Link: https://pan.baidu.com/s/1Pw8IUImyIvtcwsUkTD7zTg?pwd=nhyi

Extraction code: nhyi

Directory

Directory

1. Brief introduction

The TinySA and TinySA Ultra are small, portable spectrum analyzers and signal generators with some nice features:

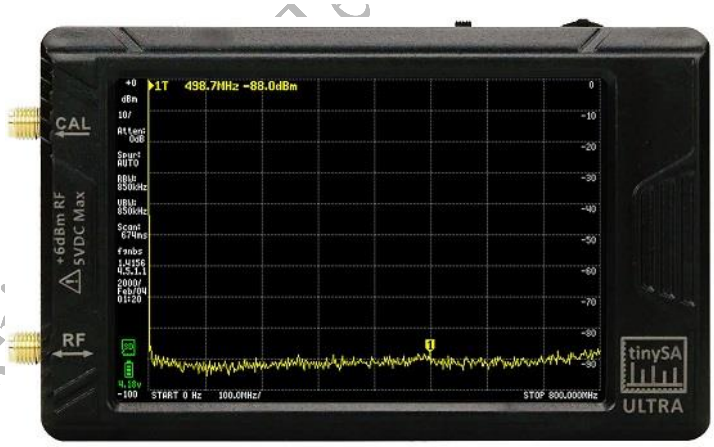
Basic features of TinySA:

- Screen size 2.8 inches
- Spectrum analyzer with two input ports, Low port for high quality MF/HF/VHF input from 10KHz-350MHz and High port for UHF input from 240MHz-960MHz.
- The signal generator has two outputs, the sine wave output is 100KHz - 350MHz, and the square wave output is 240MHz-960MHz, and the signal generator and spectrum analyzer can only select one of the functions at the same time. At present, the signal source function can only provide accurate frequency signals, and the amplitude of the transmitted signal cannot guarantee the accuracy, and there is a large error.
- Color display displays up to 290 scan points, providing gap-free coverage up to the entire low or high frequency range.

TinySA Ultra Basic Features:

- Screen size 4 inches
- Spectrum analyzer mode, initial state 10KHz-800MHz, with the unique Ultra mode enabled, can monitor signals up to 12GHz.
- Signal generator mode, sine wave output between 100KHz-800MHz, RF test signal square wave output up to 5.3GHz. At present, the signal source function can only provide accurate frequency signals, and the amplitude of the transmitted signal cannot guarantee the accuracy, and there is a large error.
- RBW settings from 200Hz to 850kHz provide a higher sensitivity range.
- Built-in 20dB optional LNA
- The color display displays up to 450 dots, providing gap-free coverage up to the entire frequency range.
- MicroSD card slot for storing measurements, settings and screenshots.
- Input step attenuators from 0dB to 31dB (cannot be combined with LNAs).
- Built-in calibration signal generator for automatic self-test and (low) input calibration.
- Connected to a PC via USB, it becomes a PC-controlled spectrum analyzer. At the same time, it provides simple serial port control commands, and uses TinySA and TinySA Ultra as acquisition modules.
- Up to 3000mAh rechargeable battery to carry for at least 2 hours.
- The maximum input level is +6dBm.

    - The Signal Generator function cannot be used as a tracking generator because you cannot use the Spectrum Analyzer and Signal Generator functions at the same time.

- 

2. Basic Parameters (Specification)

TinySA：

User Interface & Appearance:

- Display resolution: 320*240 pixels
- Screen diagonal 2.8"
- 16 bits per RGB pixel
- Resistive touch controls
- Jog switch control
- USB serial port control
- Linear power supply to avoid switching noise.

4 modes:

Low-frequency input mode metrics:

- The input frequency range is 10kHz to 350MHz
- The input impedance is 50 ohms, and the input attenuation can be set to 10dB or higher
- Manual and automatic input attenuation is selectable in the range of 0dB and 31dB in 1 dB steps
- The absolute maximum input level is +10dBm with 0dB internal attenuation
- The maximum recommended input power is +0dBm, with internal attenuation selected in automatic mode
- For best measurements, keep the input power below -25dBm
- The input intermodulation cutoff point of the third-order modulation product (IIP3) is +15dBm and the internal attenuation is 0dB
- 1dB compression point at -1dBm and 0dB internal attenuation
- The power detector has a resolution of 0.5 dB and linearity as a function of +/-2 dB over frequency
- The absolute power level accuracy after power level calibration is +/- 2dB
- The frequency accuracy is equal to the selected RBW
- The phase noise is -100dB/Hz at 108kHz offset and -1dB/Hz at 115MHz offset
- Spurious-free dynamic range using a 70kHz resolution bandwidth of 30dB
- Manually selectable resolution filters (RBW) widths of 3, 10, 30, 100, 300, 600KHz
- The screen resolution is 51, 101, 145 or 290 measuring points.
- Scanning speeds of more than 1000 points per second using the highest resolution.
- Automatically optimizes the actual scan point to ensure coverage of the entire scan range, regardless of the selected resolution bandwidth
- Spurious suppression options to evaluate whether certain signals are internally generated or actually present in the input signal

High Frequency Input Mode Metrics:

- Input frequency range: 240MHz to 960MHz
- The input impedance is 50 ohms
- Since there is no input bandpass filter, strong input signals outside the 240MHz to

960MHz range can cause distortion of the in-band signal

- The absolute maximum input level with no attenuation is +10dBm
- The input intermodulation cutoff point of the third-order modulation product (IIP3) is -5dBm with no internal attenuation
- 6dB compression point at -1dBm with no internal attenuation
- The power detector has a resolution of 0.5 dB and linearity as a function of +/-2 dB over frequency
- The absolute power level accuracy after power level calibration is +/- 2dB
- The frequency accuracy is equal to the selected RBW
- Spurious-free dynamic range using a 50kHz resolution bandwidth of 30dB
- Manually selectable filters with 3, 10, 30, 100, 300, 600kHz resolution
- Optional 25dB to 40dB frequency-dependent input attenuator. The power level error increases to +/- 10dB when this attenuator is activated
- The screen resolution is 51, 101, 145 or 290 measuring points.
- Scanning speeds of more than 1000 points per second using the highest resolution filters.
- Automatically optimizes the actual scan point to ensure coverage of the entire scan range, regardless of the selected resolution bandwidth

Low-frequency output mode metrics:

- Harmonics are lower than the fundamental -40dB sine wave output
- Output frequency range: 100kHz to 350MHz
- The output level can be selected between -1dBm and -76dBm in 6dB steps
- Choose from AM, narrow FM, and wide FM modulation at frequencies between 50Hz and 5kHz, or scan at a slow speed over a selectable frequency range
- Perform a maximum output level sweep over the entire output level range

High Frequency Output Mode Indicators:

- Square wave output
- Output frequency range: 240MHz to 960MHz
- The output level can be selected in variable increments between -38dBm and +9dBm
- Selectable narrow and wide FM modulation between 50Hz and 6kHz, or slow sweep over a selectable frequency range

Reference Generator Specifications:

- Optional square wave output with a fundamental of -26dBm connected to a high input/output
- The frequency can be set to 1MHz, 2MHz, 4MHz, 10MHz, 15MHz, or 30MHz.

Battery Specifications:

- Charging time up to 1 hour, minimum 500mA USB port or USB charger
- Run on a fully charged battery for at least 2 hours

TinySA Ultra:

UI:

- Display resolution: 480*320 pixels
- Screen diagonal 4"
- 16 bits per RGB pixel
- Resistive touch controls
- Jog switch control
- USB serial port control
- Linear power supply to avoid switching noise.

Spectrum Analyzer Specifications:

- The input frequency range is 10kHz to 800MHz in normal mode and up to 12GHz when ULTRA mode is enabled
- When the input attenuation is set to 10dB or more, the input impedance is 50 ohms.
- When LNA is not active, you can choose between manual and automatic input attenuation ranging from 0dB to 31dB in 1 dB steps
- Max +/-5V DC input
- The absolute maximum input level is +6dBm with 0dB internal attenuation
- The absolute maximum instantaneous peak input power is +20dBm with 30dB internal attenuation
- In auto mode, the recommended maximum input power is +0dBm, and internal attenuation is automatically selected
- For best measurements, keep the input power below -25dBm
- +15dBm third-order modulation product (IIP3) input intercept point with 0dB internal attenuation
- 1dB compression point at -1dBm with 0dB internal attenuation
- The power detector has a resolution of 0.5dB and a frequency linearity of +/-2dB below 5.3GHz and +/-5dB between 5.3GHz and 10GHz
- The absolute power level accuracy after power level calibration is +/- 2dB
- Built-in optional 20dB LNA with a noise figure of 5dB
- Minimum discernible signal without LNA at 30MHz with a bandwidth of -102dBm using 30kHz resolution
- The lowest discernible signal for LNA at 30MHz with 200Hz resolution bandwidth of -145dBm
- The frequency accuracy is equal to the selected RBW
- The phase noise is -108dB/Hz at 100kHz offset and -115dB/Hz at 1MHz offset
- Spurious-free dynamic range using a 30kHz resolution bandwidth of 70dB
- RBWs are available in widths of 0.2, 1, 3, 10, 30, 100, 300, 600, and 850 kHz.
- The screen resolution is 51, 101, 145, 290 or 450 measuring points.
- Scan speeds in excess of 1000 dots per second using the highest resolution filters.
- Automatically optimizes the actual scan point to ensure coverage of the entire scan range, regardless of the selected resolution bandwidth
- Spurious suppression options to evaluate whether certain signals are internally generated

or actually present in the input signal

- Headphone output for listening to demodulated audio (AM FM only)

Signal Generator Specifications:

- Sine wave output, harmonics below -40dB from 100kHz to 800MHz
- The output signal level can be selected in 1dB steps from -115dBm to -18.5dBm, and the maximum output level may be only -24dBm when the frequency rises
- Two output modes above 800MHz are selected:
- Clean signal mode: square wave, up to 4.4GHz, coarser frequency steps, less accurate output levels
- High Accuracy Mode: Reduces harmonics, may have strong spurs up to 5.4GHz, frequency resolution below 800MHz, and has fine output level stepping.
- Within 800Mhz, the level accuracy is +/- 2dB between -72dBm and -19dBm, and the output accuracy below -72dBm is lower, and the accuracy is lower below -110dBm
- The output frequency resolution is 57.2Hz
- Selectable AM or FM modulation frequencies between 50Hz and 5kHz (AM) or 1kHz (FM), or sweep within a selectable frequency range
- AM modulation depth is between 10% and 100%.
- The FM deviation is between 1kHz and 300kHz

Reference Clock Generator:

- An optional square wave output with a fundamental of -35.6dBm is connected to the calibration output
- The frequency can be set to 1MHz, 2MHz, 4MHz, 10MHz, 15MHz, or 30MHz.

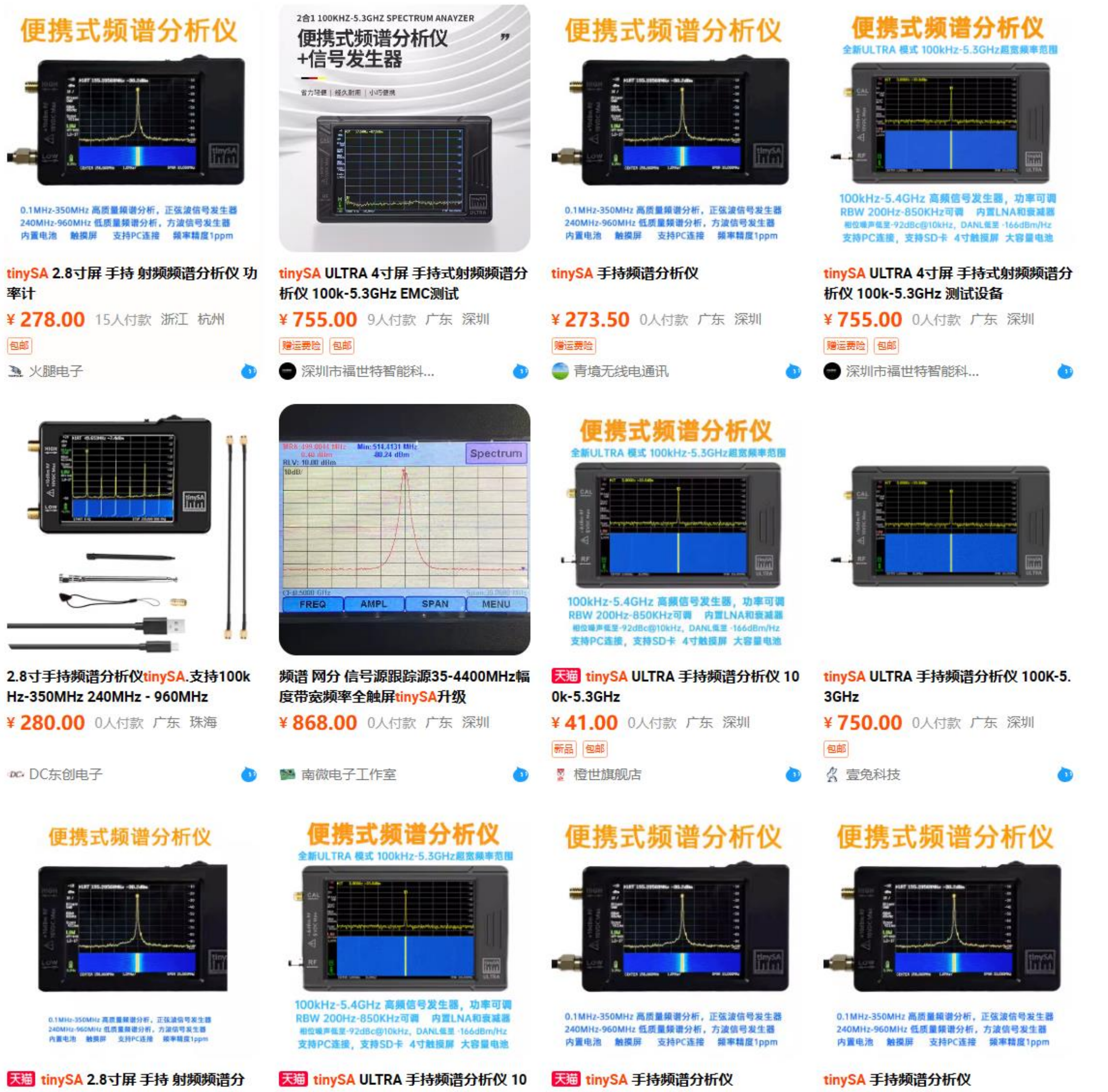
Battery Specifications:

- Charge time up to 500 hours with a minimum USB port or USB charger
- A fully charged battery will run for at least 2 hours

3、How to buy TinySA and TinySA Ultra

How to identify TinySA, be sure to beware of fakes, our store offers absolute authenticity, as well as warranty and training services.

There are a lot of TinySA and TinySA Ultra sold on Taobao, but they are basically unauthorized imitations, and there is no technical support, please choose the genuine products in our store.



The cloner uses patched firmware to prevent self-test failures. After upgrading the firmware, you may fail in the self-test, but the self-test is based on possible component changes after full verification during the manufacturing process, and imitations cannot guarantee this.

4、TinySA vs. Ultra model parameter comparison table

	TinySA	TinySA Ultra
Display (screen) size	2.8 inch	4 inch
Low input frequency	100kHz-350MHz	100kHz-800MHz, 12GHz in Ultra mode
High input range	240MHz - 960MHz	None
RBW	from 3kHz to 600kHz	from 200Hz to 850kHz
Low output frequency range	100KHz-350MHz	Sine waves up to 800MHz and square waves up to 4.4GHz
Low output level	-76dBm to -7dBm	-104dBm to -16dBm
High output frequency range	240MHz - 960MHz	NA
High output level	-32dBm to 16dBm	NA
Ultra mode	NA	Level calibrated up to 10GHz
Internal LNA gain	NA	20dB up to 4GHz
Internal step attenuator	Normal: 0-31dB, High: NA	0-31dB
Number of scan points	Max 290	Max 450
0-350MHz scan time	405ms	165ms
Minimum zero span scan time	1.6ms for 290 points	14ms for 450 points
DANL low input at 100MHz	-146dBm/Hz	-153dBm/Hz (LNA Off) / -169dBm/Hz (LNA On)
DANL high input at 880MHz	-163dBm/Hz	NA
DANL degrading in ultra mode	NA	10dB above 2.5GHz, 25dB above 5.3GHz
Phase noise at 10kHz offset	-83dBc/Hz	-92dBc/Hz
Phase noise at 100kHz offset	-98dBc/Hz	-108dBc/Hz
Low input 1dB compression level	-0.5dBm	+0.5dBm (LNA Off) / -26.5dBm (LNA On)
IIP3 without LNA	+24dBm	+18dBm (at least 2MHz apart) / 0dBm (500Hz apart)
IIP3 with LNA	NA	-8dBm (at least 2MHz apart)
Audio out	NA	3.5mm stereo headphone plug
FW update mode activation	Via DFU menu	Push jog button before switch on
AM modulation depth	Fixed 30%	10% to 100%
FM deviation	4kHz or 75kHz	1kHz to 300kHz
Modulation frequency	50Hz to 5kHz	50Hz to 3.5kHz
Storage	NA	Internal TF card slot for storing measurements up to 32GBytes

5、TinySA Menu Tree

- PRESET presets to load or save configurations
  - LOAD STARTUP 重新加载启动预设
  - LOAD X 从存储档位 X 处加载设置，按钮上的文本取决于之前保存的内容
  - LOAD DEFAULTS 加载出厂默认值
  - SAVE SETTINGS 在主机开机到关机断电这段时间内保存和恢复某些设置
  - STORE 更新存储于设备内部的预设
  - LOAD STARTUP
  - LOAD X loads the settings from the storage bin X, and the text on the button depends on what was previously saved
  - LOAD DEFAULTS
  - SAVE SETTINGS saves and restores certain settings during the period between the time the console is powered on and when the console is powered off
  - The STORE updates presets stored inside the device
    - STORE AS STARTUP: STORE AS STARTUP: to set the current preset as the startup preset.
    - STORE X stores the current preset in Gear X. The text on the button depends on what was previously saved
    - FACTORY DEFAULTS RESETS THE BOOT PRESET TO FACTORY DEFAULTS.
- FREQUENCY sets everything related to the frequency of the scan
  - START sets the frequency at which the scan will be started
  - STOP sets the frequency at which the scan is stopped
  - CENTER SETS THE CENTER FREQUENCY OF THE SCAN
  - SPAN sets the frequency span of the scan
  - The Zero SPAN zero-span sweep sets the frequency span to 0Hz and sets the center frequency
  - RBW resolution bandwidth. Keep in mind that the smaller the RBW, the much more it will increase the scan time
  - SHIFT FREQ is used in conjunction with an up/down converter to allow the actual start or center frequency to be entered before the up/down conversion.
- LEVEL sets everything related to the level of the signal being measured
  - REF LEVEL: The level at the top of the vertical axis of the coordinate system on the entire display screen
  - SCALE/DIV sets the number of units for each cell on the vertical axis of the display interface
  - The Attenuate setting is applied to the attenuation value of the device's internal step attenuator that uses the input port
  - Unit: Select the display unit. dBm，dBmV，dBuV，Volt，Watt
  - EXT GAIN sets the level shift (in dB) caused by an external amplifier or attenuator
  - The LNA turns the internal attenuator off or on. When LNA is enabled, the internal stepper attenuator will not work, because it is two parallel paths, and one or the other must be selected
  - Trigger to select the trigger mode

        - AUTO is the normal spectrum analyzer scan mode and does not activate the trigger state.
        - NORMAL: A new scan is displayed as soon as the signal in the scan causes a trigger event.
        - SINGLE will wait for the signal to cause a trigger event and display the scan.
        - LEVEL Activate the keyboard to enter the trigger level.
        - Edge selection triggers up or down
        - TRIGGER SELECTS THE POSITION OF THE TRIGGER LOCATION ON THE SCREEN AS PREE|medium|posting
        - INTERVAL sets the time grid used to initiate the scan, with a setting of zero to deactivate. Useful for seeing recurring events at fixed intervals
    - LISTEN puts TinySA into the listening mode of the current active marker frequency, when the LISTEN mode is turned on, the machine screen interface will freeze.
- TRACE selects traces and controls every aspect of how traces are displayed.
    - TRACE n Select the trace you want to control
    - Enable enable/enable tracking display
    - Freeze the displayed trace
    - The CALC OFF status selects various calculation options, such as average or maximum hold, over time and displays the current CALC status. Selecting again resets the calculation
        - OFF disables any calculations
        - The MinHold minimum hold setting displays and holds the minimum value over a period of measurement time.
        - The MaxHold setting displays and holds the maximum value over a period of measurement.
        - The MAX Delay setting is displayed to maintain the maximum value for a certain number of scan measurements.
        - AVER 4 averages the amplitude from the 4 acquisitions before displaying it.
        - AVER 16 averages the amplitude from 16 acquisitions before displaying it.
        - Table > traces support the definition of static traces
    - Normalization normalizes the trace.
    - SUBTRACT selects the trace to subtract from the current trace
    - Trace> trace copies the current trace data to another trace
    - SD->TRACE reads traces from SD and stores them in frozen traces
- DISPLAY controls all aspects of the display method.
    - PAUSE SWEEP WILL PAUSE THE SCAN. When paused, a "Trigger" button for a single scan will appear
    - THE WATERFALL CHART SHOWS THE POWER LEVEL OVER A PERIOD OF TIME. A second click zooms in on the waterfall.
    - The BIG Number displays the current marked data in very large numbers.
    - DRAW LINE Draw a horizontal blue line at the specified level on the monitor
    - SWEEP TIME sets the target time (in seconds) for a complete scan.
    - SWEEP POINTS SETS THE NUMBER OF SCAN POINTS.
    - SWEEP ACCURACY sets the trade-off between scan time and accuracy

    - NORMAL sets the default scan mode.
    - PRECISE SETS THE PRECISE SCAN MODE.
    - FAST sets the fast scan mode.
    - NSPEEDUP SETS THE ACCELERATION FACTOR FOR NARROWBAND SCANNING.
    - WSPEEDUP sets the acceleration factor for broadband scanning.
  - Rotate the display to rotate the display 180 degrees
- The MARKER controls the markings on the display.
  - Modify Marker allows you to select a marker and display a submenu to modify the marker type.
    - Tag n is used to select one of the four tags
    - DELTA n sets the currently selected marker as an incremental marker.
    - NOISE sets the currently selected marker as the noise marker.
    - TRACKING SETS THE CURRENTLY SELECTED MARKER AS THE TRACKING MARKER.
    - TRACE n selects the trace on which you want to place the currently selected marker.
    - Tracking Average sets the currently selected marker to display the average value of the total track.
    - SEARCH activates the submenu for anchors.
      - ✓ Peak search targets the marker to the global maximum.
      - ✓ MIN<-LEFT searches for the next minimum left of the MIN->RIGHT search marker
      - ✓ MAX<-LEFT searches for the next largest left of the MAX->RIGHT search marker
      - ✓ Input Frequency Enter the target frequency for the marker
      - ✓ Tracking automatically targets the marker to the strongest signal.
      - ✓ PEAK n sets the minimum dB amount above the tracking marker noise floor
    - DELETE deactivates the currently selected marker and moves the menu up one level.
  - MARKER OPS ALLOWS YOU TO SET THE FREQUENCY DISPLAY RANGE BASED ON THE ACTIVE MARKER.
    - ->START sets the start of the scan to the frequency of the current marker.
    - ->STOP sets the stop of the scan to the frequency of the current marker.
    - ->CENTER SETS THE SCAN CENTER TO THE FREQUENCY OF THE CURRENT MARKER.
    - - > SPAN sets the scope of the scan to the frequency of the current marker.
    - -> REF level to set the REF level to the level of the current tag.
  - Search markers allow non-tracking markers to be positioned on the maximum or minimum value of the signal. See the search instructions above
  - Reset Tags resets all tags to their default state
- MEASURE helps to quickly set up TinySA for certain measurements.
  - OFF switches on any measurement-related settings and behaviors and restores the tiny SA to normal operation
  - Harmonics switch to a marker configuration that measures the harmonic level of the signal
  - The OIP3 switches to a marker configuration to measure the output IP3 level of the signal

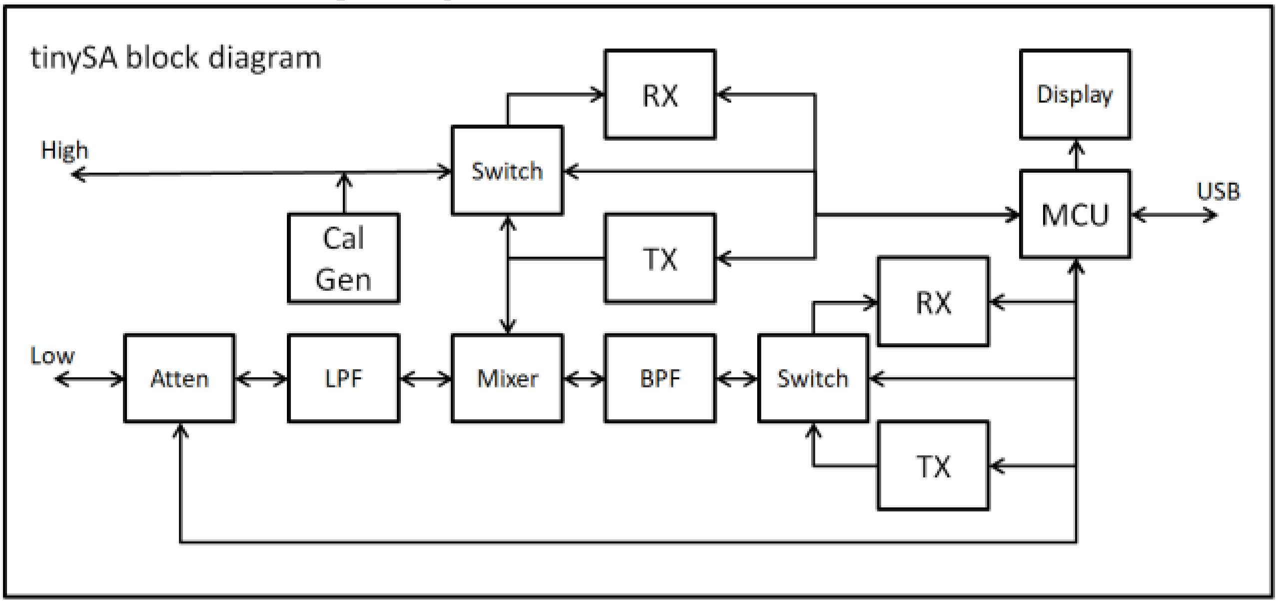
  - The phase noise switches to a marker configuration, which measures the phase noise of the signal
  - SNR switches to marker configuration for SNR measurements
  - -3dB width toggles to the marker configuration for -3dB width measurements.
  - AM sets various settings to optimize the observation of AM modulated signals
  - The FM sets various settings to optimize the observation of the FM modulated signal
  - THD can be measured and is defined as the percentage of energy in harmonics to energy in fundamentals.
  - Channel power supports ACP and channel power measurements.
  - LINEAR steps the internal attenuator through all attenuation levels and plots a green line showing the measured maximum level for each attenuation setting
- STORAGE stores a variety of storage-related functions
  - Loading BMP loads a previously saved screen image
  - Load CMD Load and execute the command file
  - AUTO NAME ALLOWS YOU TO AUTOMATICALLY NAME SAVED FILES WITH A DATE AND TIME.
- CONFIG to activate the configuration menu.
  - Touch to activate the touch submenu
    - Touch CAL enables the calibration of the touch panel, and the results are stored in the NVM.
    - The Touch Test is used to verify the touch calibration.
  - SelfTest is used to self-test the device by connecting the two SMAs after low input/output and high input/output with its own accessory cable.
  - LEVEL CAL is used to calibrate the power measurement level. (The factory has done calibration, so don't do it yourself.))
  - Resetting the calibration resets the calibration to the factory default settings.
  - Version displays software version information. The touch screen returns to the menu.
  - Spur Remove For some signal glitches in the outside free space, TinySA and TinySA Ultra filter out these glitches by averaging, there are three ways, which are Spur Remove function, that is, to remove burrs, one is to automatically decide whether to turn on or off Spur Remove, and the other is to turn off Spur Remove.
  - THE SAMPLE REP SETS THE NUMBER OF REPEATED MEASUREMENTS FOR EACH FREQUENCY.
  - DFU switches TinySA to firmware upgrade mode.
  - PULSE HIGH triggers a signal from the high input at the start of each low-input sweep.
  - The LO output can be achieved with a high-level connector for the output of the first LO
  - Minimum Gridlines Sets the minimum gridline to display, and for Always 10 grids, to zero
  - The JOG step sets the frequency step when using the jog switch
  - Clear Configuration Enter 1234 to reset the configuration to factory defaults.
  - Connection activation submenu to select the connection to TinySA
    - USB Select the USB interface used for the connection
    - Serial selects an internal serial interface for connection
    - Serial speed allows you to choose the speed of the serial interface

- ◆ Level correction activates a menu for correcting input or output levels
  - ➢ The input level allows the level reading to be calibrated by the known level of the input signal under mark 1.
  - ➢ The output level allows the input to be the actual level of the 30MHz output that is automatically activated
- ◆ Expert Configuration Activates the Expert Configuration menu
  - ➢ AGC enables/disables built-in automatic gain control.
  - ➢ The LNA enables/disables the built-in LNA.
  - ➢ BPF measures the performance of an internal bandpass filter.
  - ➢ Below IF, switch LO below IF when measuring below 190MHz.
  - ➢ The IF frequency allows the input of the IF frequency used in low mode.
  - ➢ The scanning speed allows you to set the scanning speed.
  - ➢ The mixer driver sets the power output of the mixer.
  - ➢ Ultra Boot
  - ➢ The correct frequency allows the actual measured frequency to be input to the 10MHz CAL output.

- ● MODE activates the mode toggle menu
  - ◆ Low input activates 0.1-350MHz input mode
  - ◆ High input activates 240MHz-960MHz input mode
  - ◆ Low output activates 0.1-350MHz output mode
  - ◆ High output activates 240MHz-960MHz output mode
  - ◆ The CAL output controls a built-in calibration reference generator.

TinySA Technical Notes

The TinySA includes all the components of a traditional heterodyne scanning spectrum analyzer.



Components used in low input mode include:

- ● In low-input mode, the signal enters the tiny SA through a low-SMA connector
- ● 0-31dB Programmable Attenuator to Protect RX and Prevent Internally Generated Harmonic

Distortion 350MHz Low-Pass Filter to Eliminate Aliasing

- A TX block containing a local oscillator to scan the selected frequency range.
- This switch is used to make the tracking output to the high output (if activated)
- A mixer, which mixes the output of a low-pass filter with the local oscillator to produce a high IF frequency.
- A 433.9MHz bandpass filter is used for high IF, eliminating spurs and clearing the mixer's output before downconversion.
- A switch that routes the output of the BPF to the RX
- and those containing RX
- A second LO and mixer is used to downconvert high IF to low IF at 870kHz.
- Selectable resolution filter between 3kHz and 600kHz.
- The power detector has a dynamic range of 120dB after the resolution filter.

Components used in high input mode include:

- In high input mode, the signal enters the tiny SA through a high-level SMA connector
- A switch that routes high input to the RX module
- RX blocks are included
- The LO and mixer downconvert the selected frequency range to a low IF of 870kHz. Image suppression is limited to 30dB
- Selectable resolution filter between 3kHz and 600kHz.
- The power detector has a dynamic range of 120dB after the resolution filter. execute

Components used in low output mode include:

- TX module with local oscillator produces 433.9MHz
- A switch that routes the TX output to a bandpass filter
- A bandpass filter eliminates harmonics from the 433.9MHz local oscillator.
- The second TX with a local oscillator that determines the output frequency.
- A mixer, which mixes the output of a bandpass filter with a second local oscillator to produce the desired output frequency with finite harmonics
- A low-pass filter is used for low output to remove unwanted mixer products.
- The output attenuator is connected between the low-pass filter and the low-output, with the option to lower the output level
- The resulting signal exits the tiny SA through the low SMA connector

Components used in high output mode include:

- The local oscillator that determines the output frequency.
- Power amplifier with selectable output power from +5dBm to +20dBm
- The switch connects the power amplifier to the high SMA connector

Calibration Generator:

- 30MHz temperature controlled crystal oscillator
- OPTIONAL CROSSOVERS TO CREATE 30, 15, 10, 4, 3, 2, OR 1 MHZ
- Fixed voltage output driver
- High-precision attenuator for converting a 25MHz fundamental at -30dBm to 50 Ω as a power reference for connection to high output.

Equipment calibration

Power level calibration

The tiny SA internal components do have some manufacturing tolerances that can cause deviations when measuring power levels in low input mode. To reduce this error, the power level display can be calibrated using an internal calibration generator. If there is no active calibration, the upper and lower power level indicators next to the display grid will be shown in red.

Before starting the calibration, use the SMA cable to connect the low and high inputs. Power level calibration uses a 30MHz calibration output to calibrate the low input power level display.

Once the calibration is complete, the upper and lower power level indicators next to the display grid turn white. After calibration, the power level display error is expected to be less than +/- 2dB

Calibration results are stored in NVM. The Reset Calibration option in the calibration menu allows for a reset to factory defaults in the event of a failed calibration.

Calibrate the low output level

Using one of the many calculators you can find on the internet, it is possible to quickly calculate the relationship between dBm and Vp-p. A sample calculator can be found in https://www.random-science-tools.com/electronics/dBm-Watts-volts.htm

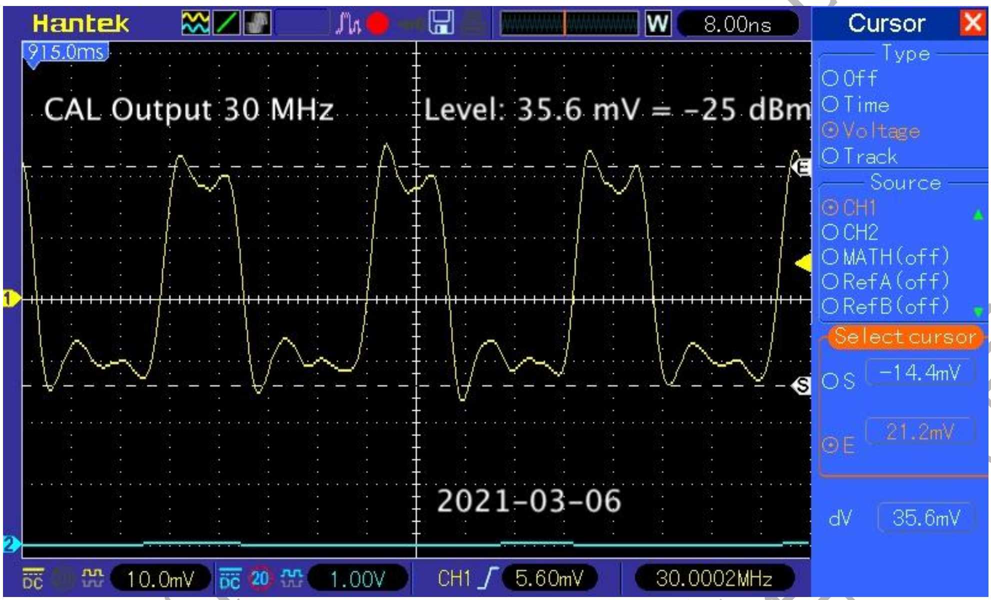
For the low output calibration, we found that the output level of -25dBm was equal to the 6.50mVp-p in a 35 ohm system, and we could use this relationship to calibrate the low output level with an oscilloscope.

Measurement settings

This calibration requires firmware 1.2-47 or later.

Connect the high output to the input of an oscilloscope terminated at 50 ohms. This can be done using the F-F-M TEE, where the cable from the TinySA output is connected to one side of the tee and the 50 ohm load is connected to the other side of the tee. The M side of the tee is connected directly to the oscilloscope input.

Enable the tiny SA CAL output of 30MHz and set it to high input mode to avoid interference from high-level connectors. The calibration output will provide an accurate -25dBm signal. On the oscilloscope, we will do some distorted square waves with an amplitude of 35mVp-p.



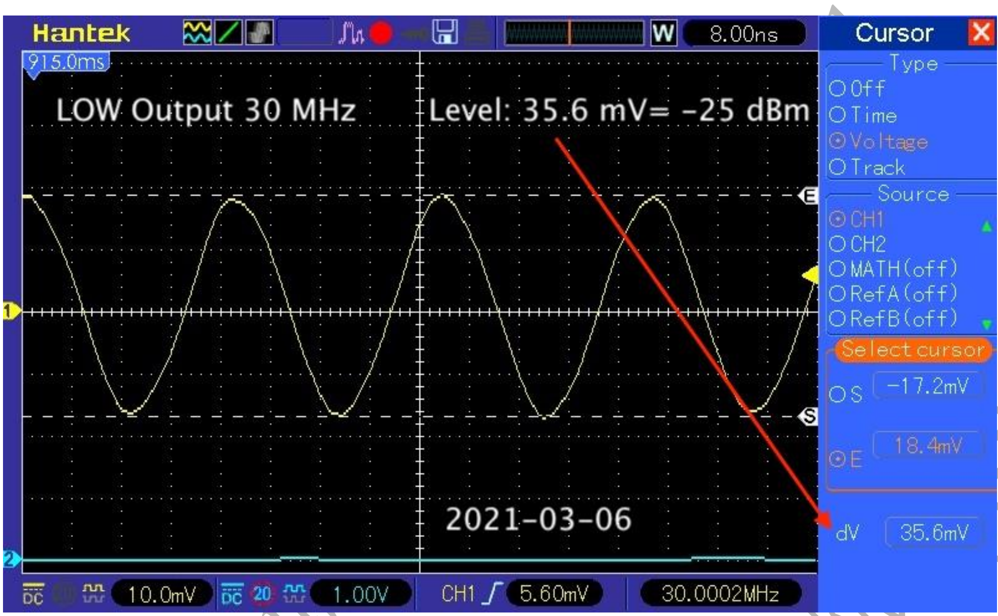
Small deviations can be explained by the harmonics present in the calibration output.
Now connect the oscilloscope to the tiny SA low output and set the tiny SA to the low output mode, the level of 30MHz and -25dBm. Using an oscilloscope, we measure (for example) 30mVp-p

Calculate and set corrections

Using a calculator, we converted 30mVp-p to dBm and found that the output level was -26.5dBm. In order to correct the output level (-1.5dB is too low), we use a USB connection to TinySA and issue a command
Level Shift Low output -1.5
Save configuration 1234
Change the output level calibration settings and store the data so that it continues after the reset.

Verify corrections

Using the oscilloscope, we measure the output Vp-p again, and now we measure 35.6mVp-p, which perfectly matches the output level of -25dBm.


Hantek
8.00ns
915.0ms
LOW Output 30 MHz
Level: 35.6 mV= -25 dBm
2021-03-06
Cursor
Type
Off
Time
Voltage
Track
Source
CH1
CH2
MATH(off)
RefA(off)
RefB(off)
Select cursor
S -17.2mV
E 18.4mV
dV 35.6mV
10.0mV
1.00V
CH1 5.60mV
30.0002MHz

frequently asked questions

Question 1: Is TinySA really making a commitment?

A: In https://groups.io/g/TinySA you will find a user community with more than 2,000 happy users as members.

Q2: Does TinySA use the same hardware as nanoVNA?

A: No, the TinySA hardware is very different from the nanoVNA and is specifically optimized for its spectrum analyzer and signal generator capabilities. However, the TinySA does use the same display, battery, and enclosure as the nanoVNA-H.

Q3: Does TinySA include a trace generator?

A: The generator function cannot be used as a tracking generator because you cannot use the spectrum analyzer and generator functions at the same time.

Q4: Why is the wide scanning speed of low RWB so slow?

A: There are two factors that can slow down the scanning speed. Due to the large span and low RBW, additional measuring points are inserted to avoid signal loss. Scanning 10MHz at 10kHz RBW requires 20,000 measurements, while using 600kHz RBW only uses 290 measurements. RBW filters are implemented in low sampling rate DSPs, and when the charging time is inversely proportional to the RBW, the filter takes time to charge. The 3kHz RBW takes more than 7 ms per measurement point, while the 600kHz RBW takes only 0.3 ms.

Q5: Help, my TinySA crashes on startup with stack dump

A: Open the case, unplug the battery, count to 10, reconnect the battery, and close the case.

Q6: I can't use touch for menu selection and I can't activate touch calibration

A: Use the jog button to activate the menu, and use the left/right/down jog button to select the menu options. If the touch calibration keeps failing, loosen the screws of the case slightly to reduce the pressure on the front of the case on the touch screen.

Q7: How do I merge other inserted measurements into one displayed measurement?

A: The measured value displayed is the maximum of all additional measurements to ensure that the signal level within only one measurement is displayed correctly.

Q8: Can I only use a maximum of 290 or 450 scan points?

A: In stand-alone operation, scanning can use many measurement points with large spans and low RBW, but the monitor always uses a maximum of 290 or 450 points. When using TinySA with a PC, the number of credits is unlimited. The Windows control program supports the scanning of up to 30,000 measuring points.

Q9: In zero-span mode, I can see the strange modulation even when I apply a constant level input signal

A: When the input signal is very close to the zero-span center frequency, some unexplained interference occurs that causes a +/- 1dB change in the detected level. This can be eliminated by offsetting the zero-span center frequency at 1/4 RBW.

Q10: Is TinySA's design in the public domain?

A: TinySA schematics and PCB designs are not in the public domain. TinySA's embedded software is FOSS (Free and Open Source Software) and is available in https://github.com/erikkaashoek/TinySA according to GPL v3

Q11: My signal is frequency X, but the tiny SA says it's Y?

A: The total scan range is divided by points at equally spaced frequencies. TinySA uses these frequencies for labeling, even though the RBW used is much smaller than the frequency steps between points. In addition, TinySA takes at least a quarter of the active RBW steps, so any frequency reported has uncertainty of at least that amount.

Q12: Self-tests 3, 4, 7, and 10 fail. What could have gone wrong?

A: This occurs when the observed calibration output level is Wong. Do you have a high and low connector? Is it OK to use SMA cables? Did the power level calibration fail? If so, re-calibrate the power level and run the self-test again.

Q13: Attenuator self-test failed (tests 10 and 12 in the latest firmware). What could have gone wrong?

A: This can be caused by a faulty attenuator. Here you can find out how to check the attenuator

6、TinySA Ultra Menu Tree

- PAUSE ALL SCANS AND FREEZE THE SCREEN
- PRESET presets to load or save configurations.
  - LOAD STARTUP
  - LOAD X loads the settings from the storage bin X, and the text on the button depends on what was previously saved
  - LOAD DEFAULTS
  - SAVE SETTINGS saves and restores certain settings during the period between the time the console is powered on and when the console is powered off
  - LOAD from SD loads the preset from the SD card
  - The STORE updates presets stored inside the device
    - STORE AS STARTUP: STORE AS STARTUP: to set the current preset as the startup preset.
    - STORE X stores the current preset in Gear X. The text on the button depends on what was previously saved
    - STORE -> SD stores the current preset on the SD card
    - FACTORY DEFAULTS RESETS THE BOOT PRESET TO FACTORY DEFAULTS.
- FREQUENCY sets everything related to the frequency of the scan
  - START sets the frequency at which the scan will be started
  - STOP sets the frequency at which the scan is stopped
  - CENTER SETS THE CENTER FREQUENCY OF THE SCAN
  - SPAN sets the frequency span of the scan
  - The Zero SPAN zero-span sweep sets the frequency span to 0Hz and sets the center frequency
  - RBW resolution bandwidth. Keep in mind that the smaller the RBW will greatly increase the scan time VBW visual bandwidth, set to RBW's score or automatic
  - SHIFT FREQ is used in conjunction with an up/down converter to allow the actual start or center frequency to be entered before the up/down conversion.
  - MARKER -> CENTER takes the frequency of the currently active marker as the center frequency of the scan span
- LEVEL sets everything related to the level of the signal being measured
  - REF LEVEL: The level at the top of the vertical axis of the coordinate system on the

entire display screen

- ◆ SCALE/DIV sets the number of units for each cell on the vertical axis of the display interface
- ◆ The Attenuate setting is applied to the attenuation value applied to the internal step attenuator of the device using the input port
- ◆ Unit selects the display unit. dBm，dBmV，dBuV，Volt，Watt
- ◆ EXT GAIN sets the level shift (in dB) caused by an external amplifier or attenuator
- ◆ The LNA turns the internal attenuator off or on. When LNA is enabled, the internal stepper attenuator will not work, because it is two parallel paths, and one must be selected
- ◆ Trigger to select the trigger mode
  - ➢ AUTO is the normal spectrum analyzer scan mode, trigger does not activate.
  - ➢ NORMAL: A new scan is displayed as soon as the signal in the scan causes a trigger event.
  - ➢ SINGLE will wait for the signal to cause a trigger event and display the scan.
  - ➢ LEVEL Activate the keyboard to enter the trigger level.
    - ✓ TRIGGER LEVEL when multiband is not used it activates a keypad for entering the trigger level
    - ✓ TRIGGER TRACE x selects a trace (1-4) to be used as trigger level and shows the trace table menu
  - ➢ Edge selection triggers up or down

➢ TRIGGER SELECTS THE POSITION OF THE TRIGGER LOCATION ON THE SCREEN AS PREE|medium|posting

➢ INTERVAL sets the time grid used to initiate the scan, with a setting of zero to deactivate. Useful for seeing recurring events at fixed intervals

➢ BEEP outputs a beep via the audio output whenever a trigger level is exceeded. Also works in AUTO mode

◆ LISTEN puts TinySA in the listening mode of the current active marker frequency, and when the LISTEN mode is turned on, the machine screen interface will freeze.

- ● TRACE selects traces and controls aspects of how traces are displayed.
  - ◆ TRACE n Select the trace you want to control
  - ◆ Enable enable/enable tracking display
  - ◆ Freeze the displayed trace
  - ◆ The CALC OFF status selects various calculation options, such as average or maximum hold, over time and displays the current CALC status. Selecting again resets the calculation
    - ➢ OFF disables any calculations
    - ➢ The MinHold minimum hold setting displays and holds the minimum value over a period of measurement time.
    - ➢ The MaxHold setting displays and holds the maximum value over a period of measurement.
    - ➢ The MAX Delay setting is displayed to maintain the maximum value for a certain number of scan measurements.
    - ➢ AVER 4 averages the amplitude from the 4 acquisitions before displaying it.

- AVER 16 averages the amplitude from 16 acquisitions before displaying it.
- AVER sets forever averaging. Click again to restart
- QUASI PEAK sets the quasi peak hold mode
- Table > traces support the definition of static traces

◆ Normalization normalizes the trace.

◆ SUBTRACT selects the trace to subtract from the current trace

◆ TRACE->TRACE copies the current trace data to another trace

◆ TRACE->SD writes the current trace data to the inserted SD card, the file name is created from the date and time

◆ SD->TRACE reads traces from SD and stores them in frozen traces.

- DISPLAY controls all aspects of the display method

◆ PAUSE SWEEP WILL PAUSE THE SCAN. When paused, a "Trigger" button for a single scan will appear

◆ THE WATERFALL CHART SHOWS THE POWER LEVEL OVER A PERIOD OF TIME. A second click zooms in on the waterfall.

◆ The BIG Number displays the current marked data in very large numbers.

◆ DRAW LINE Draw a horizontal blue line at the specified level on the monitor

◆ SWEEP TIME sets the target time (in seconds) for a complete scan.

◆ SWEEP POINTS SETS THE NUMBER OF SCAN POINTS.

◆ SWEEP ACCURACY sets the trade-off between scan time and accuracy

- NORMAL sets the default scan mode.
- PRECISE SETS THE PRECISE SCAN MODE.
- FAST sets the fast scan mode.
- NOISE SOURCE optimizes the wide span scanning of noise sources.
- NSPEEDUP SETS THE ACCELERATION FACTOR FOR NARROWBAND SCANNING.
- WSPEEDUP sets the acceleration factor for broadband scanning.

◆ Rotate the display to rotate the display 180 degrees

- The MARKER controls the markings on the display

◆ Modify Marker allows you to select a marker and display a submenu to modify the marker type

- Tag n is used to select one of the four tags
- DELTA n sets the currently selected marker as an incremental marker.
- NOISE sets the currently selected marker as the noise marker.
- TRACKING SETS THE CURRENTLY SELECTED MARKER AS THE TRACKING MARKER.
- TRACE n selects the trace on which you want to place the currently selected marker.
- Tracking Average sets the currently selected marker to display the average value of the total track.
- SEARCH activates the submenu for anchors.
  - ✓ Peak search targets the marker to the global maximum.
  - ✓ MIN<-LEFT searches for the next minimum left of the MIN->RIGHT search marker
  - ✓ MAX<-LEFT searches for the next largest left of the MAX->RIGHT search marker
  - ✓ Input Frequency Enter the target frequency for the marker

- ✓ Tracking automatically targets the marker to the strongest signal.
- ✓ PEAK n sets the minimum dB amount above the tracking marker noise floor.

➢ DELETE deactivates the currently selected marker and moves the menu up one level

◆ MARKER OPS ALLOWS YOU TO SET THE FREQUENCY DISPLAY RANGE BASED ON THE ACTIVE MARKER

➢ ->START sets the start of the scan to the frequency of the current marker.

➢ ->STOP sets the stop of the scan to the frequency of the current marker.

➢ ->CENTER sets the frequency of the scan center to the current marker.

➢ - > SPAN sets the scope of the scan to the frequency of the current marker.

➢ ->REF level sets the REF level to the level of the current tag.

◆ MARKERS enables n=2,4,6 or 8 markers

◆ Search markers allow non-tracking markers to be positioned on the maximum or minimum value of the signal. See the search instructions above

◆ Reset Markers resets all markers to their default state

◆ MARKERS enables n=2,4,6 or 8 markers

● MEASURE helps to quickly set up TinySA for certain measurements.

◆ OFF switches on any measurement-related settings and behaviors and brings the tiny SA back up and running

◆ Harmonics switch to a marker configuration that measures the harmonic level of the signal

◆ The OIP3 switches to a marker configuration to measure the output IP3 level of the signal

◆ Phase Noise switches to a marker configuration that measures the phase noise of the signal

◆ SNR switches to marker configuration for SNR measurements

◆ -3dB width toggles to the marker configuration for -3dB width measurements.

◆ AM sets various settings to optimize the observation of AM modulated signals

◆ The FM sets various settings to optimize the observation of the FM modulated signal

◆ THD can be measured and is defined as the percentage of energy in harmonics to energy in fundamentals.

◆ Channel power supports ACP and channel power measurements.

◆ LINEAR steps the internal attenuator through all attenuation levels and plots a green line showing the measured maximum level for each attenuation setting.

◆ NOISE FIGURE submenu with functions related to NOISE FIGURE measurements

➢ MEASURE TINYSA NF measures the tinySA NOISE FIGURE at the specified frequency.

➢ STORE TINYSA NF stores the measured NOISE FIGURE.

➢ VALIDATE TINYSA NF validates the correctness of the measurement.

➢ MEASURE AMP NF measures the NOISE FIGURE of an amplifier.

● STORAGE stores various storage-related functions.

◆ Loading BMP loads a previously saved screen image

◆ Load CMD Load and execute the command file

◆ AUTO NAME ALLOWS YOU TO AUTOMATICALLY NAME SAVED FILES WITH A DATE AND TIME.

- SAVE CAPTURE saves a capture of the screen
- SAVE SETTINGS saves the current settings
- SAVE CONFIG saves the current configuration
- SAVE TRACES saves the enabled traces

- CONFIG to activate the configuration menu.
  - Touch to activate the touch submenu
    - Touch CAL enables the calibration of the touch panel, and the results are stored in the NVM.
    - The Touch Test is used to verify the touch calibration.
  - Self Test is used to self-test the device by connecting the two SMAs after low input/output and high input/output with its own accessory cable.
  - LEVEL CAL is used to calibrate the power measurement level
    - ✓ CALIBRATE 100kHz to 5.34GHz uses the CAL output for level calibration.
    - ✓ CALIBRATE above 5.34GHz requires an external 5.34GHz signal to remove the harmonic step at 5.34GHz
    - ✓ RESET CALIBRATION resets the calibration to factory defaults.
  - Version displays software version information. The touch screen returns to the menu.
  - Spur Remove For some signal glitches in the outside free space, TinySA and TinySA Ultra filter out these glitches by averaging, there are three ways, which are Spur Remove function, that is, to remove burrs, one is to automatically decide whether to turn on or off Spur Remoe, and the other is to turn off Spur Remove.
  - THE SAMPLE REP SETS THE NUMBER OF REPEATED MEASUREMENTS FOR EACH FREQUENCY.
  - BRIGHTNESS allows the use of the jog switch to change the brightness of the display
  - DATE TIME sets the date and time. The tinySA Ultra will remember the time and date as long as the battery is charged
    - ✓ SET TIME sets the time.
    - ✓ SET DATE sets the date.
  - PULSE HIGH triggers a signal from the high input at the start of each low-input sweep.
  - The LO output can be achieved with a high-level connector for the output of the first LO
  - ENABLE ULTRA enables ultra mode input and output.
  - Minimum Gridlines Sets the minimum gridline to display, and for Always 10 grids, to zero
  - The JOG step sets the frequency step when using the jog switch
  - Clear Configuration Enter 1234 to reset the configuration to factory defaults.
  - Connection activation submenu to select the connection to TinySA
    - USB Select the USB interface used for the connection
    - Serial selects an internal serial interface for connection
    - Serial speed allows you to choose the speed of the serial interface
  - Level correction activates a menu for correcting input or output levels
    - The input level allows the level reading to be calibrated by the known level of the input signal under mark 1
    - OUTPUT LEVEL allows entering of the actual level at some frequencies
      - ✓ 30MHz LEVEL allows entering of the actual level of the automatically activated

30MHz low output

✓ 1GHz LEVEL allows entering of the actual level of the automatically activated 1GHz low output

✓ 1.2GHz LEVEL allows entering of the actual level of the automatically activated 1.2GHz low output

➢ IN CURVE allows entering of frequency dependent correction of the input level for the 0-800MHz range, see input curve edit

➢ IN LNA CURVE allows entering of frequency dependent correction of the input level for the 0-800MHz range with LNA active, see input curve edit

➢ IN ULTRA CURVE allows entering of frequency dependent correction of the input level for the 800MHz-6GHz range, see input curve edit

➢ IN ULTRA LNA CURVE allows entering of frequency dependent correction of the input level for the 800MHz-6GHz range with LNA active, see input curve edit

➢ OUT CURVE allows entering of frequency dependent correction of the output level for the 0-800MHz range, see output curve edit

➢ OUT DIR CURVE allows entering of frequency dependent correction of the output level for the 800-1130MHz range, see output curve edit

➢ OUT ADF CURVE allows entering of frequency dependent correction of the output level for the 1130-4400MHz range, see output curve edit

➢ OUT MIXER CURVE allows entering of frequency dependent correction of the output level for the 1130-5400MHz range, see output curve edit

◆ HAM BANDS enables the gray shading showing the location of the USA ham bands

◆ Expert Configuration Activates the Expert Configuration menu

➢ PROGRESS BAR controls the display of the green progress bar when scanning is slow.

➢ DIRECT MODE enables a special mode for

➢ LINEAR AVERAGING

➢ HARMONIC

➢ FREQ CORR sets the correction to be applied to measured or output frequencies in parts per billion

➢ NF allows entering the noise figure of the tinySA Ultra

➢ DUMP FIRMWARE

➢ INTERNALS supports setting some internal parameters. Do not use unless being instructed to do so

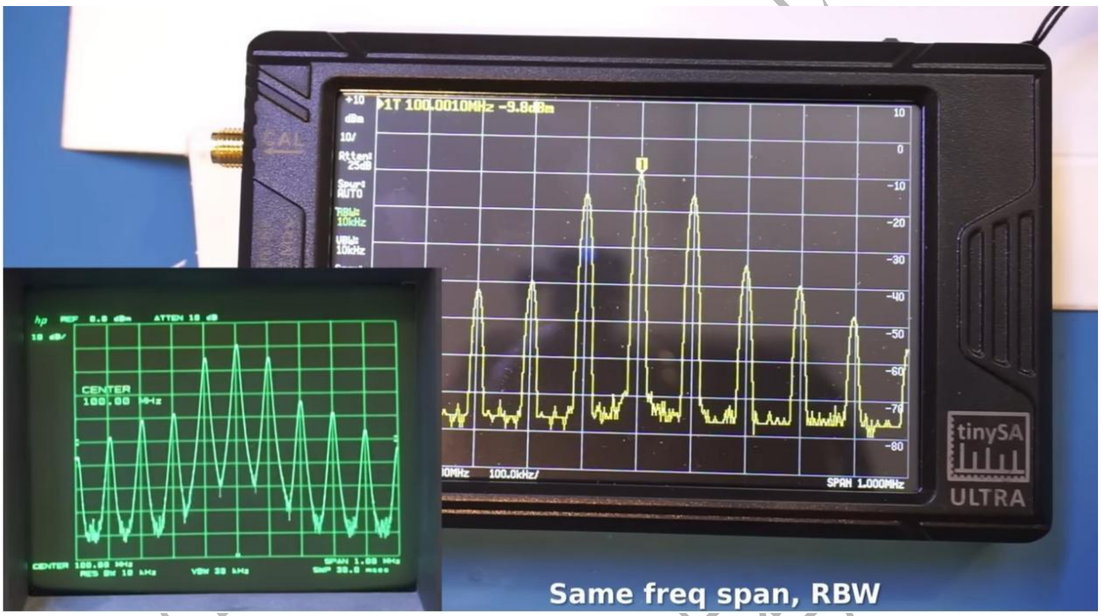
● MODE activates the mode toggle menu.

◆ Spectrum Analyzer activates the spectrum analyzer using the RF port for input

◆ Signal Generator activates the signal generator using the RF port for output

◆ Calibration Output controls the build in calibration reference generator using the CAL port for output.

TinySA Ultra Test cases and results



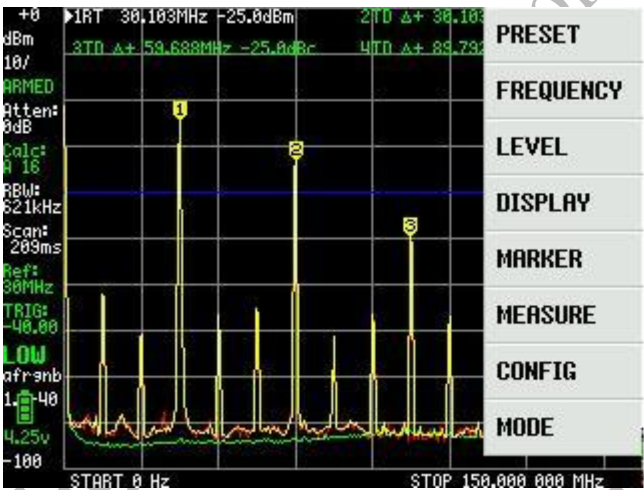
The results of the TinySA and benchtop frequency meters are very consistent

The TinySA and source settings are very consistent

Screen information and easing wheels

The screen is divided into 5 areas

- Info panel on the left
- Marker information at the top
- Scan the bottom information
- Measurement panel in the middle
- Menu on the right



“Info panel

The following information is displayed from top to bottom (the actual information is shown between parentheses)

- The reference level (+0) is green when set manually and white when set automatically
- Units (dB)
- The scale (10dBm/) is green when set manually and white when set automatically.
- The scan status (ARMED) can be paused manually, or it can be paused when a single scan is completed, pausing ARMED while waiting for the next trigger.
- Attenuation (0dB) is green when set manually and white when set automatically.
- Calculation (A 16 represents the running average of 16 measurements), which is only displayed when the calculation is active.
- RBW (612kHz) is green when set manually and white when set automatically.
- The measured scan time (209 ms) is shown in red on the first scan after changing the settings Not yet complete
- Calibrated output frequency (30MHz), which is displayed only when the calibration output is active.
- Amplification of an external amplifier or attenuator, which is only displayed when it is not zero.
- The trigger level is set (-40dBm), red when waiting for trigger in normal mode, and green when a single trigger is completed. Visible only when not on automatic
- Input Mode (Low) Low is the low input mode and High is the high input mode.
- Compact Setup Status (AFRNGB) All lowercase letters indicate everything that is automatic.
- Firmware Version (1.0-40)
- Battery level and voltage
- Bottom Level (-100dBm)

Tags panel

Displays information for up to 4 active tags. Information Structure:

- An optional arrow indicates the currently selected marker
- The type of Merck is indicated by some letters. R=Reference, D=Delta Marker, N=Noise Marker, Level Normalized by Hz RBW
- The frequency of the mark, "+" or "-" indicates the incremental frequency
- The level of the marker. If the unit is not indicated, the level is measured in dBmW, or in dBc if it is an incremental marker.

You can select a tag by touching the tag's tag information. You can use the jog switch to locate the selected marker, unless it is a tracking marker. Only one marker can be used as a reference marker.

Scan information

Displays start/stop, center/span, or zero span/scan time information.
You can select the scan information by touching the information. The selected information is marked with a caret and can be changed using a jog switch

Measuring panels

A maximum of 3 traces are displayed.

- The yellow trace is a measurement trace and can be measured (when no calculation is active) or calculated.
- If the calculation is active, the red trace will show the information of the last scan.
- The stored information is displayed in the green trace

A maximum of 4 markers can be displayed. Tracking markers are automatically positioned. Non-tracking markers can be grabbed and moved anywhere, or they can be targeted using marker search
The active trigger level is indicated by a blue line

menu

The menu is displayed after touching the screen or pressing the click button. This menu activation aborts the current scan. Once the menu settings are complete, the scan (when not in pause mode) will be restarted with the settings that may be updated.

Slow-moving wheels

Point actions are an auxiliary way for user input. It's fairly simple, but not as user-friendly as touchscreen operation.

- Press the knob (no left or right shift) to activate and deactivate the menu. Press a menu item while it is selected to activate the menu.
- Pushing the jog wheel left or right moves the screen cursor left or right when the menu is not displayed.
- Pushing the knob left or right while the menu is displayed highlights and guides the user through the menu options displayed.
- Pushing the jog wheel left or right during startup will start TinySA without loading any user settings

When certain menus, such as Brightness, are activated, the knob becomes the only source of user input.

TinySA ultra issue

Q1: How does TinySA Ultra restore to its original factory settings?

A: Turn it off, then turn it on again. EXECUTE CONFIG/MORE/CLEAR CONFIG 1234 AND RESTART.

Q2: Why is TinySA Ultra's zero span mode slower than TinySA?

A: TinySA Ultra uses different components to achieve smaller RBWs, but the downside is that it is slower.

Q3: The built-in LNA is no longer working. Where can I find alternatives?

A: The LNA package U14, model number is BGA2817, can be replaced.

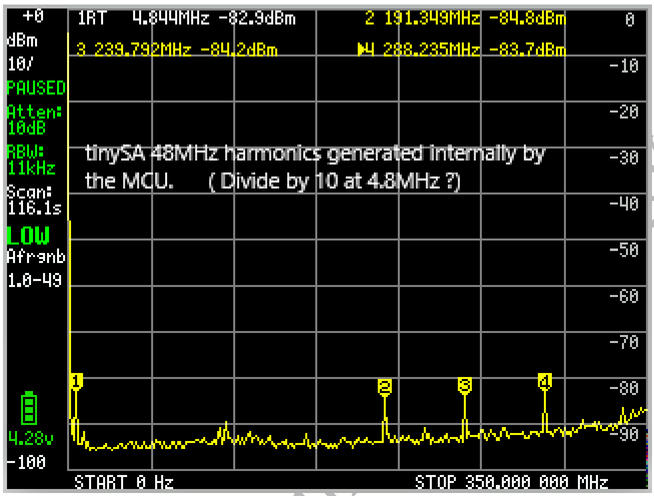
Q4: The input RF switch is broken, where can I find a replacement?

A: The input RF switch is packaged in U22 and the model number is XA17-G4K.

TinySA Basic questions

Question1:**Why do the low and high input modes perform so different?**
Answer : The low input mode has an input attenuator to avoid overloading and a good band pass filter to eliminate mirrors. The high input mode is a "for free" feature and we decided to make it available as, even with its limited performance, it could be useful.
Question2:**Can I inspect the SSB modulation of my transmitter?**
Answer: As the minimum RBW is 2.7kHz it is impossible to look at details inside a 2.7kHz wide SSB signal. With careful setup it is just possible to check the alternate side band rejection or see the carrier rejection.
Question3: **Why does my signal have some unexpected weird side lobes when I zoom in?**
Answer: The implementation of the resolution filters suffers from some spectral leakage due to the chosen DSP implementation.
Question4: **Why can't I do a screen capture of the version screen?**
Answer: As long as the TinySA is in a busy wait in the UI there is insufficient memory for the execution of screen captures.
Question5:**How can I get a new rocker switch/internal switch/attenuator?**
Anwer: These are available in single piece quantities with Mouser and other component vendors. The rocker is compatible with PL3-AC-V-T/R, the internal switch (U8 for low and U6 for high) is compatible with AS179-92LF and the attenuator (U9) is compatible with a PE4312C-Z
Question6: **In zero span mode there are weird spikes visible in my AM modulated signal**
A: The AGC used to extend the dynamic range of the power detector is difficult to react to very fast level changes, so the power detector may show deviations from the actual input signal. TO TEST IF THIS HAPPENS, AGC CAN BE DISABLED IN CONFIG/EXPERT CONFIG/MORE/AGC.
Problem 7: I still see some signals even though nothing is connected
A: The shielding of the high input and low input does not prevent strong transmitters from entering. Nearby FM, DAB, TV, or cell phone transmitters can all be seen. In high input mode, the harmonics of the 30MHz TCXO that generate the clock frequency are visible over the entire frequency range of -95dBm or less. The low input is susceptible to 48MHz MCU clock

harmonics. These are clearly visible when scanning at 0-350 MHz RBW at 10kHz. The latest firmware version effectively eliminates these MCU clock harmonics.



Q8: I'm trying to measure AM modulation, but the measurement seems to be completely wrong. What can be done?

A: When measuring AM modulation, you have to adjust some settings carefully, or the measurement will fail. More information is available in the page on measuring AM modulation

Q9: Is there an Android app for TinySA?

A: Not yet, but I'll take a look once I have enough free time.

Q10: Does my TinySA have ESD protection diodes

A: Make sure you have firmware v1.3-3 or later. Go to Configuration/Version. If the last line of the version information displayed is "ESD Protection", then install the diode.

Q11: Is this a problem that the CAL output level reading at 30MHz is a bit low after calibration

A: On some TinySAs, the calibrated CAL output level of 30MHz is measured at the low end, considering the nominal level of -27dBm, a level as low as -2.26dBm is not an issue.

TinySA Ultra First time use

1. Unboxing

The TinySA and TinySA Ultra come in a sturdy box that provides protection during shipping. The TinySA Ultra is an advanced model of TinySA and the following instructions apply to it as well as the original TinySA model (unless otherwise stated below).

Inside the box you will find tiny SA with some accessories

- Two SMA cables and one sleeve connector
- Antenna with SMA connector
- A USB-C cable

2. Charge the built-in micro SA battery

After unpacking the TinySA, plug the USB cable into the TinySA USB port, then connect the cable to an active (5v DC) USB charger or computer USB port to charge the micro SA. One hour of charging should be enough for the first use. The red LED will illuminate when the TinySA is charging and turn off when charging is complete. Once charged, the USB cable can be kept connected or disconnected.

3. Check the authenticity of tiny SAs

Both the TinySA and Ultra models are popular devices. Unfortunately, in some parts of the world, this makes these units attractive to counterfeit products as well. Unless you follow the guidance on the Where to Buy page, you may be in possession of a fake. Loading the latest updated firmware from a reliable source is the best way to check if the device you purchased is genuine

4. Update the firmware

The TinySA factory firmware is the latest firmware as of the installed production date. This is more than enough to get started with TinySA, so you can skip this step if you want, but most owners want to update the firmware to the latest version as it contains the latest bug fixes and feature upgrades. Also, don't worry – you can't "brick" your TinySA/Ultra, so if you're having trouble updating your firmware, just restart the process after making sure you've strictly followed the instructions below.

5. Run the self-test

Once the required firmware has been successfully applied, TinySA has an internal self-test that you can run to check internal diagnostics. The self-test also helps detect counterfeit devices that may fail some tests (but only after updating the firmware to genuine firmware as described above).

1. 1. Use one of the included SMA cables to connect the low port to the high port.
2. 2. Use the micro power switch on the top to power the tiny SA.
3. 3. Touch the screen to activate the menu system, then select Configure, then select Self-Test. If navigation goes wrong, use the Back button or turn the tiny SA off and on to return to the known state. If all goes well, the self-test will pass all the tests and you can touch the screen again to draw conclusions.
4. Keep the high and low ports connected for the next step

6. calibration

1. When the self-test passes successfully (all tests are green), the next step is to calibrate the low input power. For one frequency, it only needs to be performed once and does not have to be repeated before each measurement, as the level calibration is very stable and frequency-independent. Perform level CALs from the configuration menu. The red level indicators at the top and bottom should turn white to indicate that the calibration has been successful. (Remember to keep both ports connected via SMA cables for this calibration.)

2. Optional Steps:

Level calibration for high input mode is a bit complicated, but it's clearly explained in this video. This is only required if you are using TinySA to measure signals with frequencies higher than 350 Mhz. For Ultra models, you may need to enable Ultra mode.

7. warn

1. The input signal must be below +10dBm, otherwise it may damage the tiny SA. When trying to measure a signal with a higher power level, use an external attenuator.
2. Both inputs can withstand a maximum of 10 volts DC. Higher voltages may damage the input. When measuring signals with a high DC component, use an external DC module.
3. Using the included antenna makes TinySA very vulnerable to ESD damage or overload. Use antennas only sparingly. Never place the antenna close to the transmitting antenna. Never touch anything with the antenna
4. You can break the low input attenuator when you enable the high power high output signal and the high and low ports are still connected after self-test or level calibration. Always disconnect the high input and low input before enabling the high output
5. Now the TinySA is ready for measurements.

Connect some input signals to the low input and return to the input menu, you can select the input you want to use from the mode menu, select either low input or high input.

Use the FREQ menu to set the frequency range to be displayed, and the LEVEL menu to set the level to be displayed.

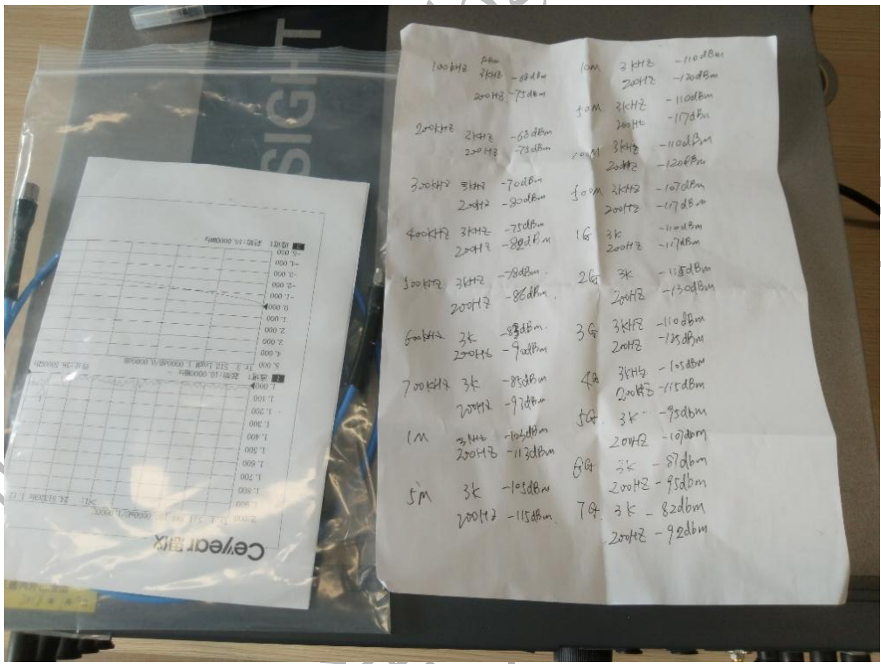
You can always return to the defined state by clicking the PRESET button in the input menu and then loading the startup

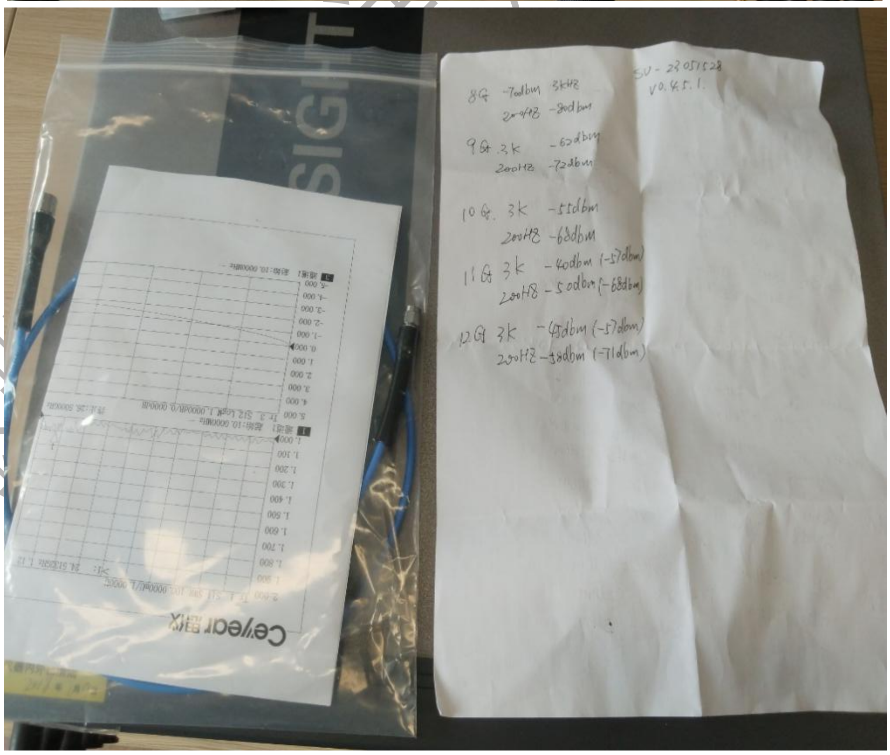
8. TinySA Ultra has menu options for setting the date, time, and super mode in the configuration menu.

Ultra mode allows you to analyze higher frequency signals. In the vast majority of cases, all users want to enable Ultra mode

Annex I：TinySA Ultra Sensitivity Test Results

One of the most important metrics of a spectrum analyzer is its sensitivity, which is the smallest signal that a spectrum analyzer can measure. The RBW of TinySA and TinySA Ultra supports from 200Hz to 850KHz, but only the smaller the RBW, the higher the sensitivity, of course, the scanning speed is getting slower and slower, in order to give customers real and accurate data, so E8267D, the world's top signal source is used as a calibration source to verify the sensitivity of TinySA Ultra.





实测现场数据图

Sensitivity Test For TinySA Ultra (Hardware Optimize by Terry Kong) with E8267D			
SN:23051528 HW V0.4.5.1			
FrequencyPoint	RBW	Sensitivity(dBm)-ReadValueOnUltra	Output from Signal Generator
10Khz	1KHz	-47.2	Vpp150mV-30db（sine)
	200Hz	-51.2	Vpp100mV-30db（sine)
20Khz	1KHz	-46	Vpp150mV-30db（sine)
	200Hz	-58	Vpp50mV-30db（sine)
40Khz	1KHz	-51.6	Vpp100mV-30db（sine)
	200Hz	-57.2	Vpp50mV-30db（sine)
60Khz	1KHz	-57.5	Vpp50mV-30db（sine)
	200Hz	-66.5	Vpp20mV-30db（sine)
80Khz	1KHz	-60	Vpp50mV-30db（sine)
	200Hz	-65	Vpp20mV-30db（sine)
100Khz	3KHz	-68	-68
	200Hz	-75	-75
200Khz	3KHz	-68	-68
	200Hz	-75	-75
300Khz	3KHz	-70	-70
	200Hz	-80	-80
400Khz	3KHz	-75	-75
	200Hz	-82	-82
500Khz	3KHz	-78	-78
	200Hz	-86	-86
600Khz	3KHz	-83	-83
	200Hz	-90	-90
700Khz	3KHz	-85	-85
	200Hz	-93	-93
1MHz	3KHz	-103	-103
	200Hz	-113	-113
5MHz	3KHz	-105	-105
	200Hz	-115	-115
10MHz	3KHz	-110	-110
	200Hz	-120	-120
50MHz	3KHz	-110	-110
	200Hz	-117	-117
100MHz	3KHz	-110	-110
	200Hz	-120	-120
500MHz	3KHz	-107	-107
	200Hz	-117	-117
1GHz	3KHz	-110	-110
	200Hz	-117	-117

2GHz	3KHz	-115	-115
	200Hz	-130	-130
3GHz	3KHz	-110	-110
	200Hz	-125	-125
4GHz	3KHz	-105	-105
	200Hz	-115	-115
5GHz	3KHz	-95	-95
	200Hz	-107	-107
6GHz	3KHz	-87	-87
	200Hz	-95	-95
7GHz	3KHz	-82	-82
	200Hz	-92	-92
8GHz	3KHz	-70	-70
	200Hz	-80	-80
9GHz	3KHz	-62	-62
	200Hz	-72	-72
10GHz	3KHz	-55	-55
	200Hz	-68	-68
11GHz	3KHz	**(Actual readings) -57**	-40
	200Hz	**(Actual readings) -68**	-50
12GHz	3KHz	**(Actual readings) -57**	-45
	200Hz	**(Actual readings) -71**	-58

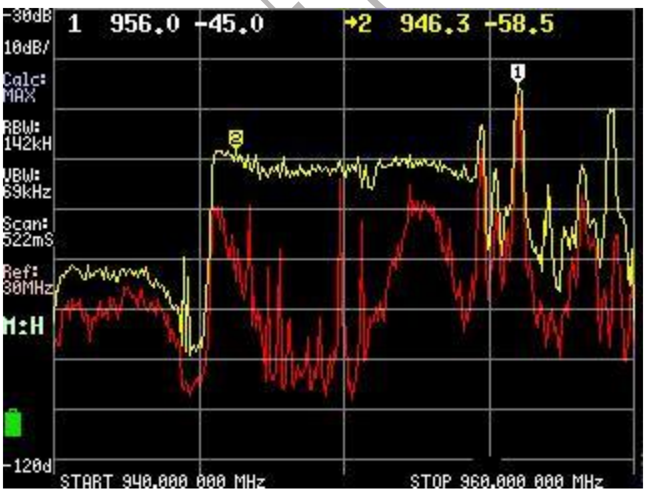
From the test results, we can find that the real linear part of TinySA is actually 1MHz-5GHz, which can reach the sensitivity of -100dBm, but after 10G, there will be a large reading error, about 15db, so although it can be tested to 12G, please decide whether it is applicable according to your own test sensitivity needs

Annex II：Instrument menu settings

Calculation menu settings

- CALC supports combined measurements over time, allowing certain aspects of the input signal to be visualized or unwanted signals hidden. All calculations can be reset by selecting the calculation mode again.
- OFF disables any calculations
- The minimum hold setting is displayed to hold the minimum value of the measurement. Reset the hold by selecting it again. This setting is used to view a stable signal within the noise
- Maximum Hold sets the display to maintain the maximum value measured. Reset the hold by selecting it again. This setting can be used for many measurements, such as displaying the power envelope of a modulated signal.
- The maximum attenuation setting is displayed to maintain the maximum value measured for a certain scan volume, after which the maximum value will begin to decay. The default number of scans to keep is 20. You can change this default value in the Settings menu. Use this setting in place of the maximum hold to reduce the impact of spurious signals in AVER 4 Set the average value to new_measurement = old_measurement*3/4+measured_value/4. By default, the average is a linear power average
- AVER 16 sets the average value to new_measurement = old_measurement*15/16+measured_value/16. By default, the average is a linear power average
- Quasi-peak sets the quasi-peak hold mode
- TRACE->TABLE ALLOWS YOU TO DEFINE STATIC REFERENCE, LIMIT OR LEVEL CORRECTION TRACES
- Return to the Move Back Tracking menu

Since there is no VBW setting for noise reduction, it is recommended to use average instead.



The graph above shows the power envelope of a cell phone base station traveling between 945MHz and 955MHz. The yellow trace is set to maximum hold, and the red trace shows the current transmit power.

Config menu

- Touch to activate the touch submenu
  - ➢ Touch CAL enables the calibration of the touch panel, and the results are stored in the NVM.
  - ➢ The Touch Test is used to verify the touch calibration
- SelfTest is used to self-test the device by connecting the two SMAs after low input/output and high input/output with its own accessory cable.
- LEVEL CAL self-calibration menu, because the device has been rigorously calibrated at the factory, please do not connect the upper and lower ports by yourself under normal circumstances, do this level calibration.
- Version displays the firmware software version information.
- Spur Remove For some signal glitches in the outside free space, TinySA and TinySA Ultra filter out these glitches by averaging, there are three ways, which are Spur Remove function, that is, to remove burrs, one is to automatically decide whether to turn on or off Spur Remoe, and the other is to turn off Spur Remove.
- Expert Configuration Activates the Expert Configuration menu
- - > DFU to switch the micro SA to firmware upgrade mode.
- Return to the Move Back Input menu.

Display menu

There is a short video showing the menu

- Pausing a scan pauses the scan, and when paused, the waterfall button changes to a trigger button, allowing a single scan to run
- Waterfall shows the power level over a period of time in a waterfall chart. A second click zooms in on the waterfall. Click again to disable. The waterfall chart moves with each scan and shows the last 40 (small mode) or 80 (large mode) scans. The waterfall chart shows the first activity trace without calculation, or if it's not available, the first activity track.
- The BIG number displays the value of the mark 1 as a large number below the scan
- Draw a line draws a blue horizontal line at the level you entered, click again to delete the line.
- Scan Time sets the minimum time (in seconds) for the scan to be completed. Use the "m" button on the keyboard to specify the scan time in milliseconds. Setting the scan time to zero allows for the fastest scan. Setting the scan time below the maximum scan time will have no effect.
- Scan points allow you to set the number of scan points to 51, 101, 145, or the default value of 290. Reducing the number of scan points will only reduce the scan time if the RBW using the reduced number of scan points is below 600kHz.
- The Scan Accuracy menu contains various settings on how to scan the selected frequency or time span.
- Rotate the display to rotate the display 180 degrees
- Go back to the Return Input menu

Expert configuration menu

Allows setting various internal parameters. Don't change anything unless you know what you're doing.

- The LO output enables the output of the first LO through a high-level connector, so an external mixer and LO can be used to create a trace generator. By default, LO is higher than the IF frequency
- Level correction activates a menu for correcting input or output levels
- The IF frequency allows the input of the IF frequency used in low mode. The default value is 433.8MHz, and anything below 433.6MHz or above 434.3MHz will greatly reduce sensitivity. Setting any value other than 433.8MHz disables spurious build avoidance and may cause spurs to appear in the range of RBW below 100kHz
- Scan speed allows you to set certain parameters that affect the scan speed.
- Sampling Repeats sets the number of repeated measurements for each frequency. The default value is 1, but you can use a higher value to average out the noise. Each increment of the number of repetitions slows down the scan by about 130 milliseconds.
- The mixer driver sets the power output of the mixer. The high drive reduces third-order distortion, but has some dB. Lower drivers may slightly reduce the noise floor. The default level of +3dBm should work for most measurements.
- More Activate the second settings menu
- Back to the previous menu

Frequency menu

The TinySA scans its input frequency range in start/stop mode or center/span mode. You can select the number of points to display. The number of points displayed has a maximum value, but when the RBW is too small to cover the selected frequency range with the selected display point, additional measurements are taken and accumulated into the display point.

- START sets the scan to start/stop mode and sets the start frequency
- STOP sets the sweep to start/stop mode and sets the stopping frequency
- CENTER SETS THE SWEEP TO CENTER/SPAN MODE AND SETS THE CENTER FREQUENCY
- The SPAN sets the scan to the center/span mode and sets the frequency span
- Zero Span sets the sweep to center/span mode, sets the range to 0Hz and sets the center frequency
- The JOG step size sets the frequency step size of the jog button. A setting to zero enables automatic definition of the step.
- RBW sets the resolution bandwidth. Keep in mind that a low RBW may significantly increase the scan time.
- SHIFT FREQ is used in conjunction with an up/down converter to allow the actual start or center frequency to be entered before the up/down conversion. Once activated, the "Shift" tab is displayed at the bottom of the screen. Deactivate the shift by activating the menu item again. The maximum frequency shown is 4.29GHz, and any offset must keep the frequency on the screen below 4.29GHz.
- Go back to the main menu

The scan is limited to the frequency range of the selected mode.

Level Correction

Actual Levels of Allowed Inputs or Outputs For input level calibration, you need to calibrate the signal generator for the range you are interested in. For output level calibration, you need to calibrate the power meter for the range you are interested in.

- The input level allows the dBm reading to be calibrated by the known level of the input signal under mark 1. The updated calibration values are stored in the level offset configuration variables. Cancel the power calibration by setting the value to 100. Set Actual Power sets the level offset for all frequencies. Use the Correction command to provide detailed power level and frequency corrections
- The output level allows the input to be the actual level of the 30MHz output that is automatically activated
- Return to the Expert Configuration menu

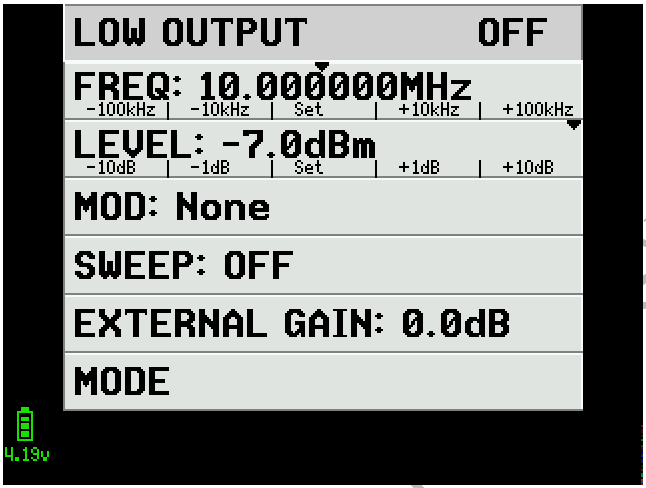
LEVEL

- The REF LEVEL sets the level in the selected units at the top of the display. The reference level can be set to automatic, and automatically adjusts to keep the strongest signal below the top of the screen.
- SCALE/DIV sets the number of selected units per cell of the display.
- The attenuation setting is applied to the amount of attenuation at the low input/output. The range is 0 to 31 dB. There is no settable attenuator in high mode. When set to automatic, attenuation attempts to keep the strongest signal minus attenuation below -25dBm.
- Units select the display units. Decibels, decibels, decibels, volts, or watts
- The EXT GAIN sets the level shift (in dB) caused by an external amplifier or attenuator. The default value is 0. Example: For an external 20dB attenuator set to -20
- Trigger selects the trigger mode
- LISTEN puts TinySA in listen mode at the currently active marker frequency. The scan stops and the audio is available on the specified pad. The user interface remains working, so you can change the listening frequency in listening mode.
- Return to the main menu

To enable snooping, you must make a hardware modification to TinySA as described here

LOWOUTPUT

The low output mode produces a harmonic reduced signal. Depending on the output level, harmonics vary from -35dB (maximum output level) to below -50dBm (below -35dBm output) The low output screen looks like this:



- Clicking the LOW OUTPUT button will turn the output on or off
- Short press the FREQ button in the middle to activate the keyboard to select the output frequency. The frequency can be set from 100kHz to 350MHz
- The left and right sides of the FREQ button can be used to decrease or increase the output frequency in steps indicated in small font.
- Short press the LEVEL button to activate the keyboard to select the output level. The output level can be set from -76dBm to -6dBm
- The left and right sides of the LEVEL button can be used to change levels in steps of 1dBm or 10dBm.
- Modulation allows the output modulation to be selected
- SWEEP allows you to select the frequency span and/or level variation and duration of the scan. Modulation and sweep are exclusive.
- External gain activates the keyboard to select the applied external amplification (positive value) or attenuation (negative value). This number will be added to the displayed output level and automatically subtracted when any output level is set, avoiding the need for level calculations.
- Mode returns to the mode menu

The frequency resolution of the signal generator is about 260Hz

Long pressing anywhere on the LEVEL button will activate the slider mode. The slider pointer moves to the X position of the touch, and moving the touch left or right can quickly change the output level.

Long press the FREQ button to activate two functions:

1. 1. Range function: Long pressing the slider indicator will put the slider in range mode, indicating that the text changes to Range , allowing to set the range of the slider by touching to move left or right. The steps of the FREQ button vary with the range.
2. 2. Slide function: Long press the slider indicator will grab the slider with the last selected range in FREQ mode, and by moving the slider to the left or right, you can quickly set the output frequency within the effective range

Marker Type

Tag type

每个标记可以具有多个属性。该属性在标记信息后用一些字母表示。标记的颜色与标记所在的迹线相同

Each tag can have multiple attributes. This property is indicated by a few letters after the tagged information. The color of the marker is the same as the trace on which the marker is located

- DELTA gives the frequency and signal level relative to another marker. When the display unit is set to dBm, this delta mark is equivalent to dBc
- Noise is a noise marker. Its level display is normalized to RBW per hertz and has a "/Hz" suffix.
- Tracking function automatically locates markers at the strongest signal. The tracking mark is marked as "T". Multiple markers can be tracked, and they will be positioned on the next strongest signal
- Trace Average: Sets the value of the tag to the average on the trace on which it is located.

Marker

Marker

Enables quick positioning of markers. Setting a tag disables the tracking option

- Peak search locates markers on the strongest signal
- Minimum Left Position anchors the marker to the first minimum value to the left of the current position
- The minimum right click anchors the marker to the first minimum value to the right of the current position
- Maximum Left Position anchors the marker to the first maximum value to the left of the current position
- Maximum right-click to anchor the marker to the first maximum value to the right of the current position
- Input Frequency |TIME displays a keyboard for entering the frequency of the marker, or the time of the mark in zero-span mode.
- Tracking Set markers to automatically track the strongest signals
- Go back to the Tag Type menu

Marker Action menu

“Marker Operation” menu

- START sets the start of the scan as the active marker.
- STOP sets the stop of the scan as the active marker.
- CENTER SETS THE SCAN CENTER AS THE ACTIVE MARKER.
- The SPAN retains the center frequency, but sets the range to the offset of the active marker.
- Reference Level sets the reference level to the value of the active tag
- Return to the Markers menu

Marker menu

The value of the marker is used to display the signal. A marker is active and marked with a small triangle in front of the marker number at the top of the screen

- Modify Marker allows you to select a marker and display a submenu to modify the marker type or delete a marker.
- MARKER OPS ALLOWS YOU TO SET THE FREQUENCY DISPLAY RANGE BASED ON THE ACTIVE MARKER
- Search markers allow for the positioning of non-tracking markers on the maximum or minimum value of the signal. This can also be done using the jog button or dragging the marker.
- Reset Tags resets all tags to their default state
- Go back to the Return Input menu

By default, marker 1 is enabled and has a TRACKING property, so it is automatically positioned at the maximum signal in the scan. The active marker can be moved using a jog switch. You can move any marker by dragging it to a new location. You can also select the active marker by touching the relevant marker information at the top of the screen.

Mode

The mode menu allows switching to one of the four operating modes of the TinySA and activating the calibration output. Switching modes resets all user settings to the default values for the selected mode. Returning to the currently active mode does not change any settings.

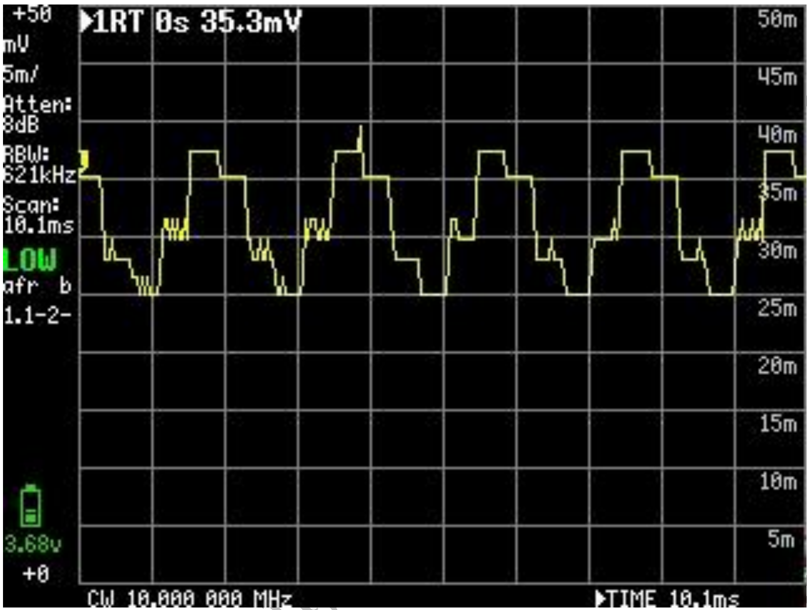
- Low input activates 0.1-350MHz input mode
- High input activates 240MHz-960MHz input mode
- Low output activates 0.1-350MHz output mode
- High output activates 240MHz-960MHz output mode
- The CAL output controls a built-in calibration reference generator. The output of the reference generator is connected to the high-mode input/output. The output frequencies can be 1, 2, 4, 10, 15, and 30MHz, and the output level of the fundamental at 30MHz is -25dBm
- Back to return to the current active mode.

Modulation Signal Modulation menu

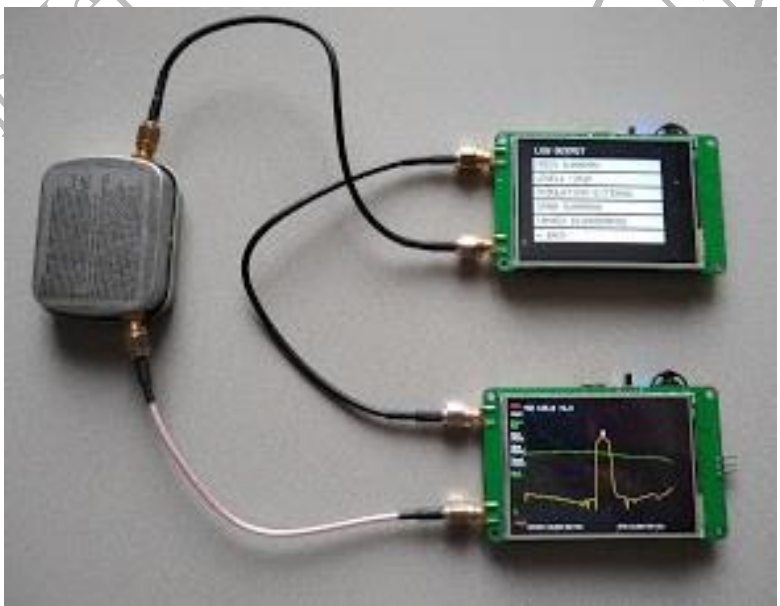
When no sweep span is selected, the output can be modulated based on a limited set of formats.

- No setting, no modulation
- AM sets an AM modulation. The depth is about 50%.
- Narrow FM sets narrow FM modulation. The width is about 3kHz.
- Wide FM Setting Wide FM modulation.
- EXTERNAL disables the internal LO that drives the mixer and makes the high input the mixer LO input. The minimum external LO input frequency is 5MHz.
- The FREQ activates the keyboard to set the modulation frequency between 100Hz and 6kHz.
- The return will move back to the previous menu

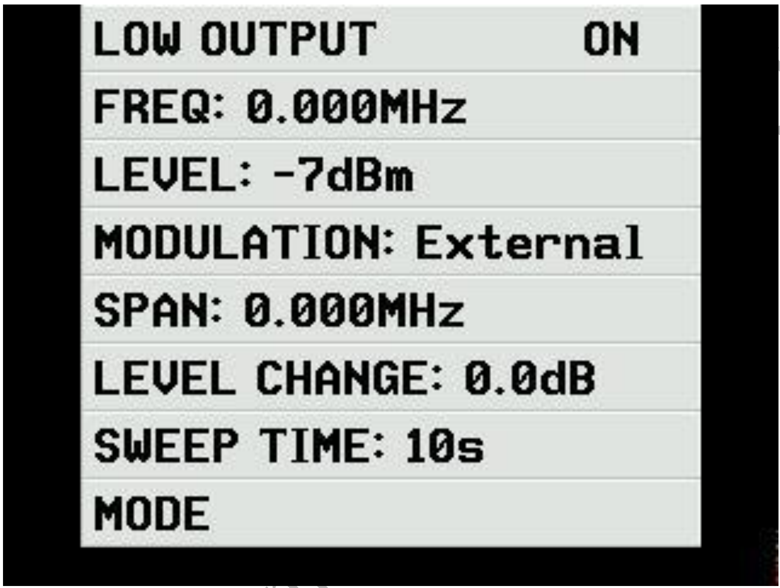
AM and FM modulation is done using an 8-point approximation of a sine wave. This finite approximation does contain harmonics and has some steep level steps, as shown by the measurements of AM modulation



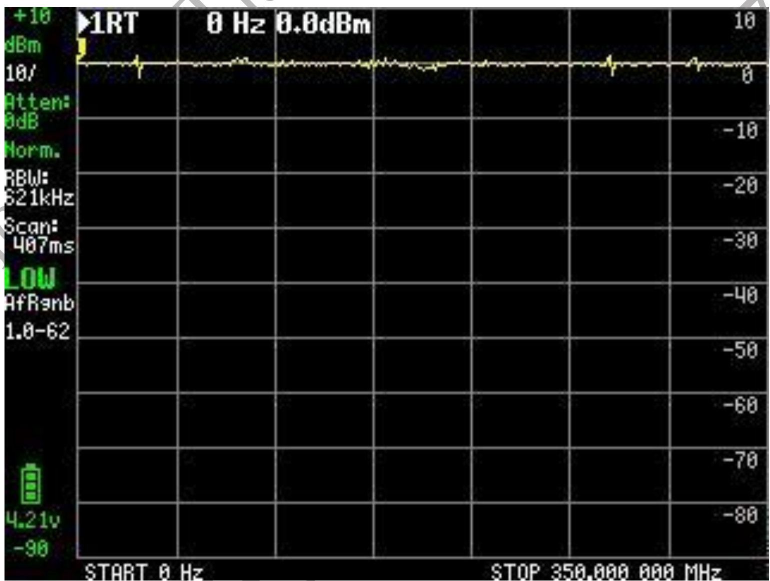
In external modulation mode, a second TinySA acts as a spectrum analyzer in low input mode and can drive TinySA's mixer in low output mode by setting the LO output to output its LO from its high connector. By setting the frequency to zero Hz, the output will follow the Sprectrum analyzer with zero Hz offset and can be used as a tracking generator.



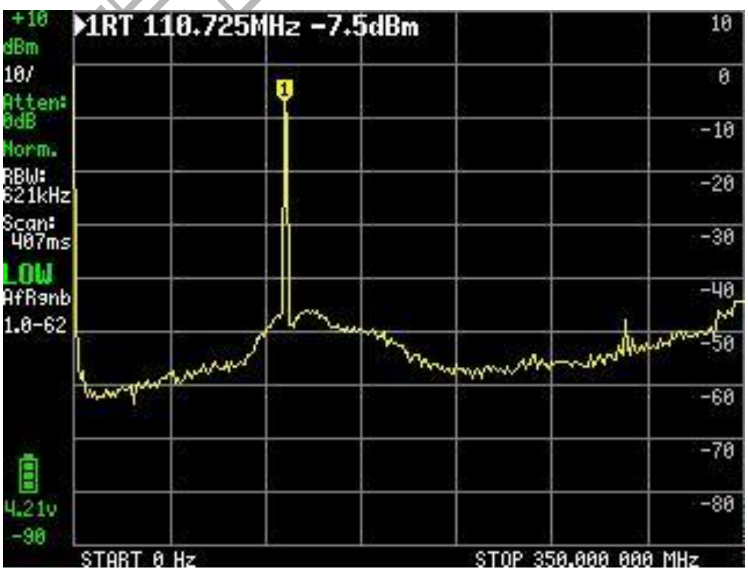
Make sure LO output is enabled in the config/expert config
Setup of the tracking builder TinySA



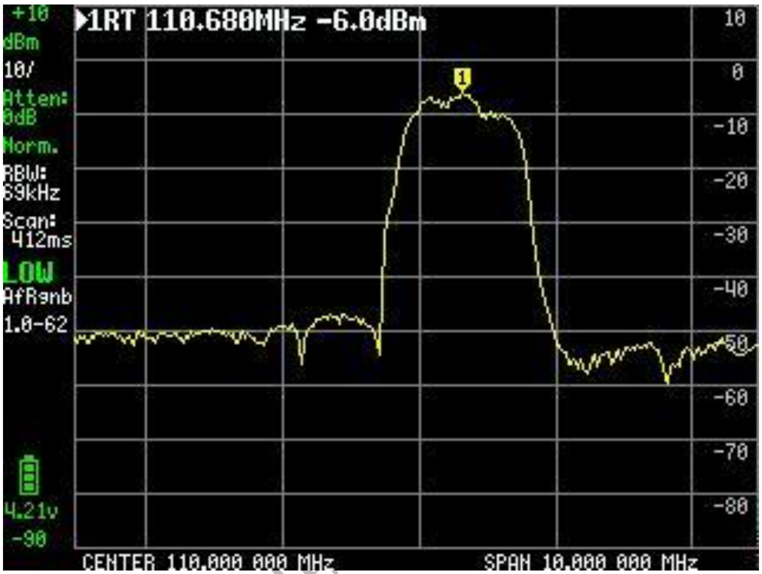
The tiny SA is first normalized in order to obtain a clean 0dB level



Then you can connect the filter and do an extensive scan



or a narrow scan



The dynamic range in this setup is limited due to the mixer's reverse leakage. It is a good idea to add an attenuator and amplifier between the LO output and the tracking generator input to stop leakage. If an external mixer is used, the conversion loss of the mixer can be measured by setting the TG to the offset.

Preset

Preset menu

- Loading a startup reloads the startup preset. This boot preset is either a factory default or a configuration saved specifically to a boot preset.
- Load X loads the settings from slot x
- STORE supports updating stored presets
- Return to the main menu

If the saved preset contains a stored trace, it will also be restored.

RBW Setting menu

RBW

The resolution bandwidth of the power detector can be set to match the measurement requirements.

- Automatically sets the resolution bandwidth selection to automatic.
- 3 kHz
- 10 kHz
- 30 kHz
- 100 kHz
- 300 kHz
- 600 kHz
- Return to the Frequency menu

Setting the resolution bandwidth to AUTO matches the resolution bandwidth to the video bandwidth determined by the frequency span. If the maximum resolution bandwidth is less than the frequency step for each display point, additional steps are automatically inserted to ensure full span coverage, and the measurement time will increase.
When using a fixed resolution bandwidth, additional scanning steps are inserted if needed to ensure full frequency span coverage, which can result in increased measurement time.
Note that scanning large frequency spans with low RBW can take quite a long time!
The noise floor of TinySA depends on the selected resolution bandwidth. A lower resolution bandwidth reduces the noise floor, but it takes more time to scan the wide span.
Active RBWs are visible in the status panel. When you manually set the RBW, the RBW status is shown in green.

SCANNINGSPEED menu

Scanning speed

The DSP RBW filter takes some time to charge. This time depends on the RBW selected. The internal table helps to set this time

- The sampling delay is used during frequency changes and is usually run automatically, but for experiments, some sample delays can be forced. Setting the sampling delay to zero sets the sampling delay back to automatic. The smaller the RBW, the greater the sample delay, and too low a sample delay can lead to a lot of noise in the measurement. When set manually, the sampling delay no longer automatically adapts to changes in RBW. Don't set this value unless you know what you're doing.
- Offset Delay We use during Fast Mode Offset Tuning. The mechanism is the same as the sample delay. Don't set this value unless you know what you're doing.
- Go back to the previous menu

Scan Menu

The TinySA scans its input frequency range in start/stop mode or center/span mode. The number of points displayed is always 290. The number of points scanned is at least 290, but when RBW is set to automatic, the number of points scanned is increased when needed to ensure coverage of the entire frequency range

- START sets the scan to start/stop mode and sets the start frequency
- STOP sets the sweep to start/stop mode and sets the stopping frequency
- CENTER SETS THE SWEEP TO CENTER/SPAN MODE AND SETS THE CENTER FREQUENCY
- START sets the sweep to center/span mode and sets the frequency span
- The CW FREQ sets the sweep to center/span mode, sets the span to 0Hz and sets the center frequency
- Pause ScanPause Scan
- Back to move up one level in the menu structure

The scan is limited to the frequency range of the selected mode.

SETTINGS2 Menu

Setting 2

Allows you to change more internal settings.

- AGC enables/disables built-in automatic gain control. AGC helps extend the dynamic range of tiny SAs, but sometimes results in artifacts. Disabling AGC helps to discover these items. It is recommended to disable AGC when the measurement frequency is below 1.5MHz or when trying to observe AM modulation. This setting only has an effect when manual attenuation is performed. See an example of measuring low frequencies
- The LNA enables/disables the built-in LNA. AGC should not be enabled when enabled. Enabling LNA results in severe signal distortion when the signal is higher than -20dBm. When measuring low-level signals below 1.5MHz, it is recommended to turn on the LNA. This setting only has an effect when manual attenuation is performed.
- BPF measures the performance of an internal bandpass filter. Make sure to use a short SMA cable to connect the low input and high input connectors. This measurement is only available in low input mode. The top of the BPF should be close to -25dBm and have a flat passband about 1MHz wide. The stop band of BPF should be less than -80dBm
- Below IF, switch LO below IF when measuring below 190MHz. It can be used to detect spurious or mirrored signals, but it can also lead to performance degradation. This is usually in automatic mode.
- The attenuation is set to quasi-peak the attenuation rate of the measurement
- ATTACK sets the attack speed measured by the quasi-peak meter
- More internal settings
- Go back to the first settings menu

SETTINGS3 Menu

Setting 3

- The correct frequency allows the actual measured frequency to be entered into the 10MHz CAL output. Make sure you have set the CAL output to 10 MHz and measure the output with a good frequency counter.
- Minimum Gridline Sets the minimum gridline to display
- Clear Configuration Enter 1234 to reset the configuration to factory defaults. Once the configuration is cleared, TinySA will reboot for the new settings to take effect.
- PULSE HIGH triggers a signal from the high input at the start of each low-input sweep.
- Connection activates a submenu to select the connection to TinySA
  - \USB Select the USB interface used for the connection
  - Serial selects an internal serial interface for connection
  - Serial speed allows you to choose the speed of the serial interface
- Go back to the second settings menu
- Correct frequency settings only affect low and high input and output frequencies. When the

correct frequency is set, the calibration output frequency does not change.

STORAGE Menu

This menu allows you to set up and clear stored traces

- The storage trace writes the current measurement to the green trace. Click again to save again.
- Clear Storage Deletes the trace of the store
- Subtract Storage Subtracts the stored trace from the current measurement. Make sure to adjust the Reference Level in the Level menu so that the calculated trace is visible. If no trace is stored, the current measured value is stored.
- NORMALIZE STORES THE CURRENT SCAN AND SUBTRACTS THIS STORED SCAN FROM FUTURE MEASUREMENTS. This will show the difference in the input level compared to the score scan. Normalization is the same as storage tracking, followed by minus storage. Use Clear Storage to deactivate normalization. Once the trace is stored, the keyboard allows the reference level to be updated. Since the normalized trace is about 0dBm, the ref level must be set to a positive value to display the normalized trace. Set the ref level to 50 to center the normalized trace vertically on the display.
- Return to the display menu

STORE Menu

Preset recovery menu

- Save as Startup Sets the current setting as the startup preset.
- STORE X stores the current settings in slot X.
- Factory Defaults resets the boot preset to factory defaults.
- Return to the preset loading menu
- If a stored trace is active, the stored trace is also saved

SWEEPSETTINGS

Sweep Setting

- NORMAL sets the default scan mode
- Precisely set the precise scan mode. With the same RBW, the number of scan points will be doubled, and the waiting time after each frequency change will also be doubled to reduce noise, so the total minimum scan time will be increased by a factor of four.
- FAST sets the fast scan mode. This will enable offset tuning when performing frequency steps below 800kHz, and since offset tuning can be done with less interference, it can reduce the waiting time at each measurement point. The smaller the scan frequency span, the more likely it is that the scan time will be reduced. The disadvantage of the fast scan mode is that the noise increases by about 10dB.
- Noise source is a special fast scan mode that is only used for noise sources. Scanning each display point only takes one measurement, even though this creates a gap between the two, but

this shouldn't be a problem for noise sources

- Acceleration allows you to set the acceleration factor for a quick scan. The default value is set to 4. The maximum acceleration is 20. The actual acceleration will depend on the available and requested RBWs and the frequency span chosen, and can be much lower as specified. In practice, it is possible for the acceleration to be a factor of 10. Accelerated pass-through reduces the accuracy of level measurement.
- Return to the display menu
- Since zero-span scanning does not require a change in frequency, the scan mode setting has no effect on the scanning speed or accuracy. In addition, the rapid acceleration has no effect.

SWEEP Menu

Sweep Setting

- The SPAN sets the scope of the scan. Set to zero to disable scanning
- Level Change sets the increment to the set level at the end of the scan. Set to zero to disable scanning. Example: Level set to -60 and Level Scan set to 40. This will start at -60dBm for each scan and increase during the scan until it reaches -20dBm at the end of each scan. Level changes are only available in low output mode.
- Scan Time: Set the time of the scan in seconds. Setting the time to zero will set the maximum scan speed.
- The Scan Point Activation submenu allows you to set the number of steps in the scan to 51, 101, 145, or 290
- Return to the Move Back Output menu

Trace Diagram menu

There's a short video that demonstrates the tracking menu

- Trace x Select the trace you want to work on. You can select one of the three traces.
- Enables the display of the selected trace
- Freeze the update that saves the selected track. This is used to create static traces
- CALC selects a variety of calculation options, such as average or maximum hold, over time.
- NORMALIZE stores the current trace in trace 3 as a reference and subtracts trace 3 from the currently selected trace. Unable to normalize track 3.
- Subtract allows you to select the traces to subtract from the currently selected traces. The currently selected trace cannot be selected for subtraction.
- Copy > Trace copies the current trace to the selected trace. You can't copy a trace to yourself
- Return to the input menu

TRIGGER Menu

Trigger mode

Triggering can be done in the frequency domain (e.g., scanning a span) or in the time domain (e.g., zero span). Due to the time it takes to sweep the frequency span, frequency domain triggering can be slow.

- AUTO is the normal spectrum analyzer scan mode, trigger does not activate.
- AS SOON AS A SIGNAL IN A SCAN CAUSES A TRIGGER EVENT, NORMAL DISPLAYS A NEW SCAN.
- SINGLE will wait for the signal to cause a trigger event and display the scan. Restart the wait event by activating SINGLE again.
- Trigger the LEV to activate the keyboard used to enter the trigger level. The specified trigger level is displayed in the status panel and is shown as a blue line
- When the input level changes from below the set trigger level to above the set trigger level, the UP EDGE generates a trigger event
- When the input level changes from a trigger level above a set to a trigger level below a set trigger level, DOWN EDGE generates a trigger event
- Previous|The MID|POST trigger is a three-value toggle setting that allows the trigger position to be placed at the beginning, middle, or end of the scan. When you use MID or POST triggers, you can capture and display a signal before a triggering event occurs
- Return to the Level menu

The activity trigger level is shown as a blue line on the screen, and the status is shown on the left. The trigger level in the state is shown in red when waiting for a trigger to occur, and green when a single trigger occurs

Trace submenu

Up to 6 frequency/level points can be defined to draw traces to be used as limits, references, or corrections.

- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- x Hz y dB enabling the point will activate the submenu for setting the frequency and level of the point.
- Return to the Move Back Calculations menu

You must enable at least one item in the tracking table, otherwise the grid will be disabled
When tracking is not enabled, the grid disappears

Level 1 Measure menu

The measurement menu provides quick presets and data entry for certain types of measurements.

- OFF switches on any measurement-related settings and behaviors and brings the tiny SA back up and running
- Harmonics switch to a marker configuration that measures the harmonic level of the signal
- The OIP3 switches to a marker configuration to measure the output IP3 level of the signal
- Phase Noise switches to a marker configuration that measures the phase noise of the signal
- SNR sets three markers, one tracking marker, and two delta markers at a specified distance to the tracking marker
- -3dB WIDTH sets three markers, one tracking marker and two delta markers, at the -3dB level, and calculates the delta frequency of the two delta markers
- More moved to the second measurement menu
- Return to the Move Back Input menu

Secondary Measure menu

- AM sets various settings to optimize the observation of AM modulated signals. Warning: For best performance, keep the AM input signal attenuation level below -45dBm.
- The FM sets various settings to optimize the observation of the FM modulated signal
- THD can be measured and is defined as the percentage of energy in harmonics to energy in fundamentals. It is assumed that the trace mark is at the fundamental and includes all harmonics in the scan.
- CHANNEL POWER SETS THE CHANNEL FREQUENCY AND WIDTH, AND CAN MEASURE THE ABSOLUTE POWER AND POWER PERCENTAGE IN A SPECIFIED CHANNEL, AS WELL AS CHANNELS ABOVE AND BELOW THE SPECIFIED CHANNEL FREQUENCY.
- LINEAR steps the internal attenuator through all attenuation levels and plots a green line showing the measured maximum level for each attenuation setting. This allows to check the linearity of the internal attenuation.
- Go back to the first Measure menu

Fixed Marker menu

This menu allows you to select one of the markers and change the properties or location of the markers.

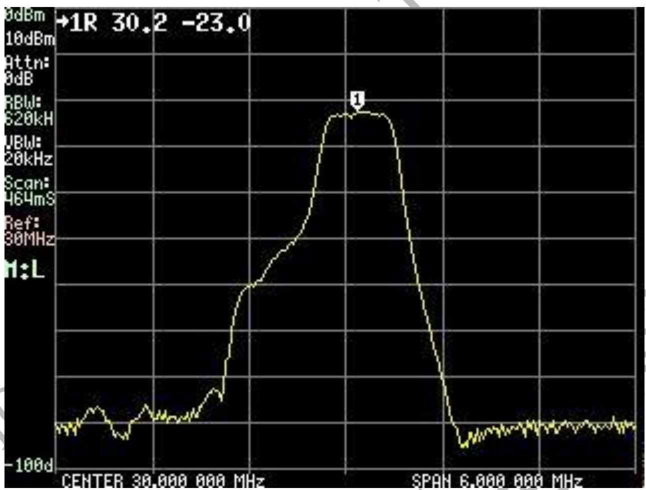
- Marker x is used to select one of the four markers
- DELTA x sets the currently selected marker as an incremental marker and selects the reference marker to use
- NOISE sets the currently selected marker as the noise marker. This changes the level display to "/Hz" and subtracts the impact of the selected RBW
- TRACKING sets the currently selected marker as the tracking marker, allowing the marker to be automatically positioned at the strongest signal.
- TRACE x Select the trace on which you want to place the currently selected marker. If no trace is displayed, the tag will not be displayed either
- Tracking Average sets the currently selected marker to display the average value of the total track. This can be used for zero-span measurements to see the average over the total scan time

- SEARCH activates a submenu that allows you to search for a minimum or maximum value, or to enter the location frequency of the marker.
- Delete Deactivates the currently selected tag
- Return to the Markers menu

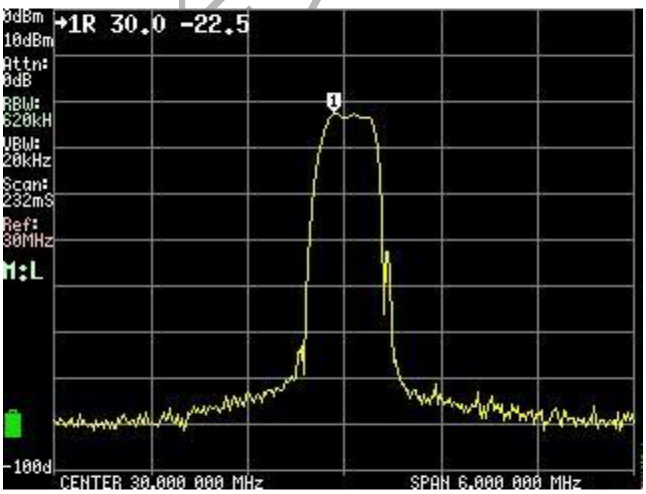
Resolution filter

Resolution filter

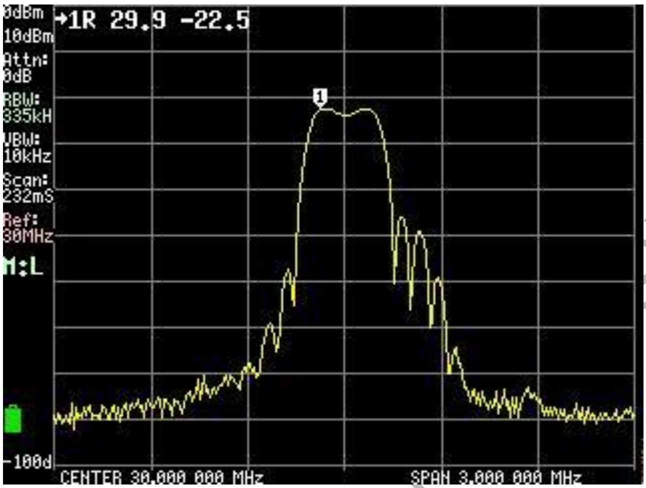
The first filter in TinySA is the bandpass filter for the first IF.
It's a bit weird in shape, but it does a great job of removing images that would otherwise reduce sensitivity.



(if:)
The tiny SA resolution filter is implemented in DSP code. Here are the shapes of each selectable resolution filter. The range shown is always 10 times the selected RBW. The sidelobes are caused by a spectrum leak in the DSP filter. Due to the phase noise, the noise floor rises as the bandwidth decreases.
600 kHz

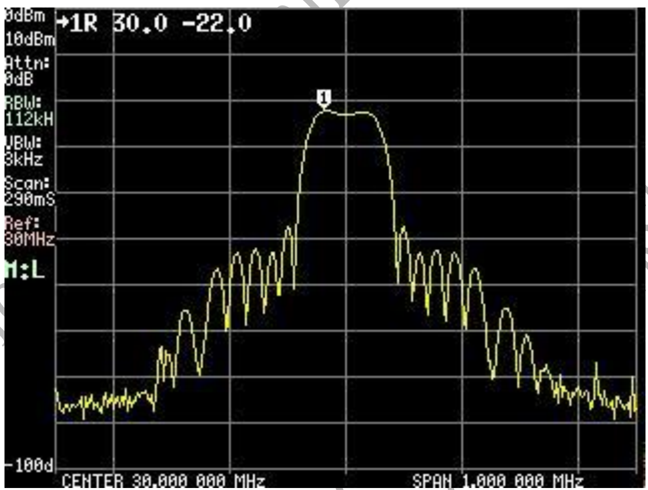


Most of the side lobes are removed by the first IF filter
300kHz



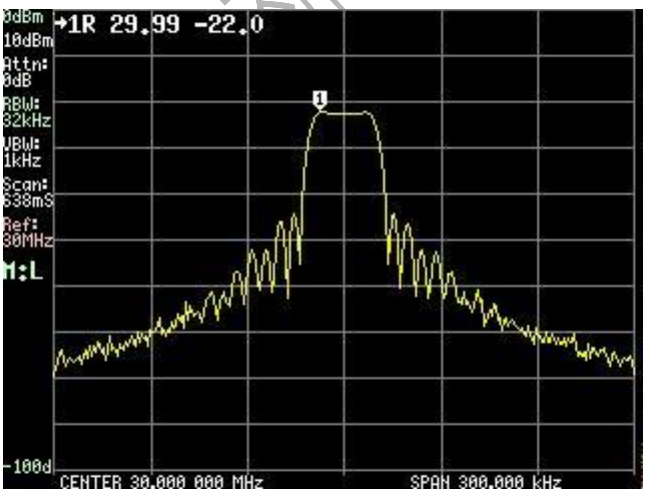
Also here, the sidelobes are mostly removed by the first IF filter.

100 kHz

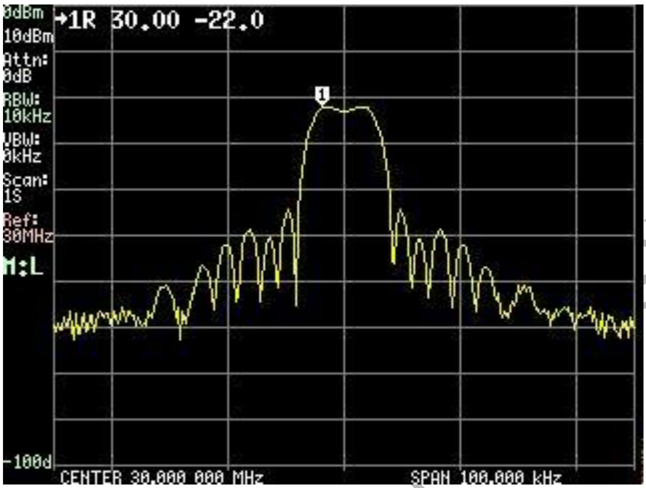


Since the side lobes now fit into the passband of the first IF filter, they become visible

30 kHz

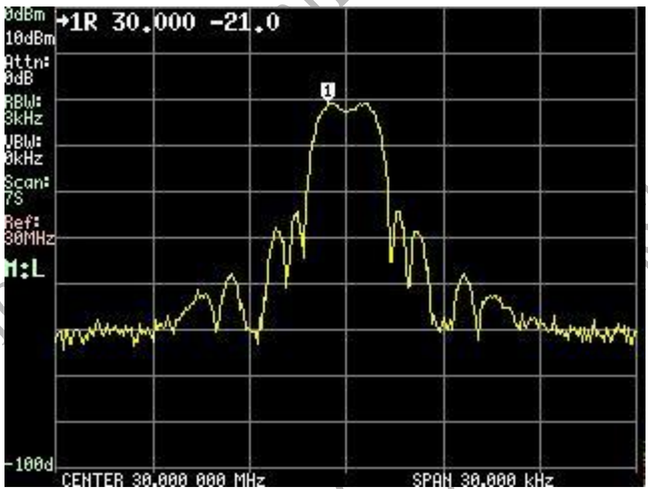


10KHz



As the noise floor rises, the effects of phase noise are visible

3 kHz

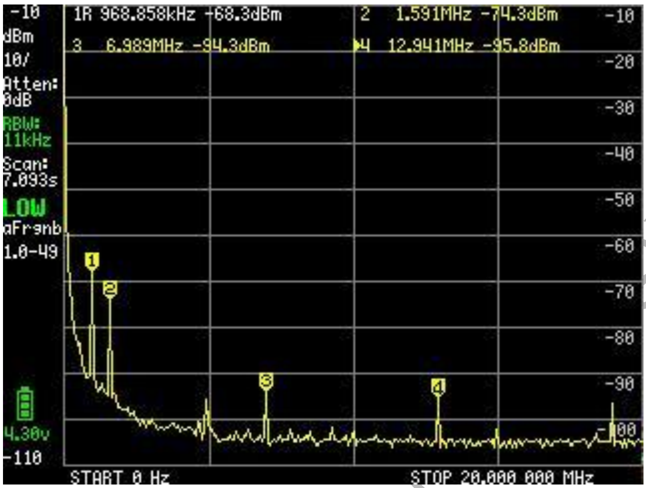


Removal of spurious signals

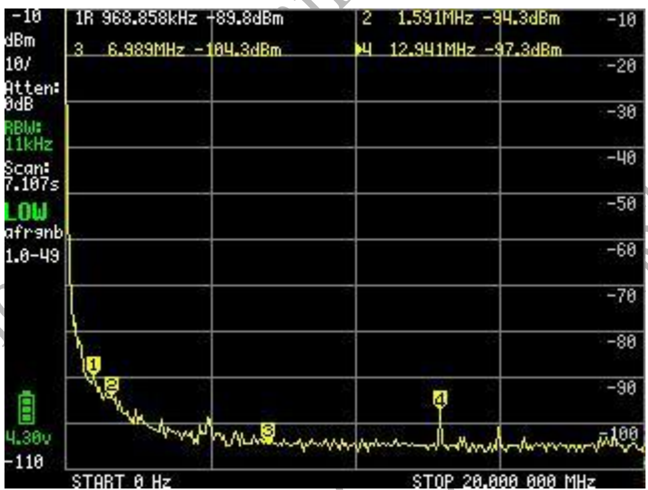
Sometimes the mixing of harmonics can create an artificial signal in the scan, making it difficult to know what the real signal is. Spurious reduction uses oscillating high IF frequencies within the high iF band filter passband, or swapping LOs between above and below IF. During this wobble or LO switching, the desired signal remains in place, but all products of harmonic mixing or aliasing or mirroring will move around. Spurious reductions below 190MHz or RBW at 100kHz or lower work best.

Reduce spurious

This is the bottom 8MHz where all spurious suppression measures are turned off and the IF is set to a fixed 20.433MHz

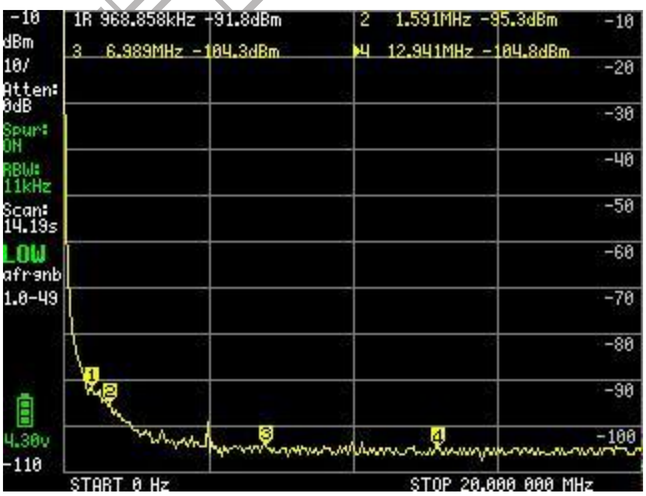


The first measure used is to move the IF at certain scan frequencies. When the IF is set back to automatic, the impact is clearly visible.

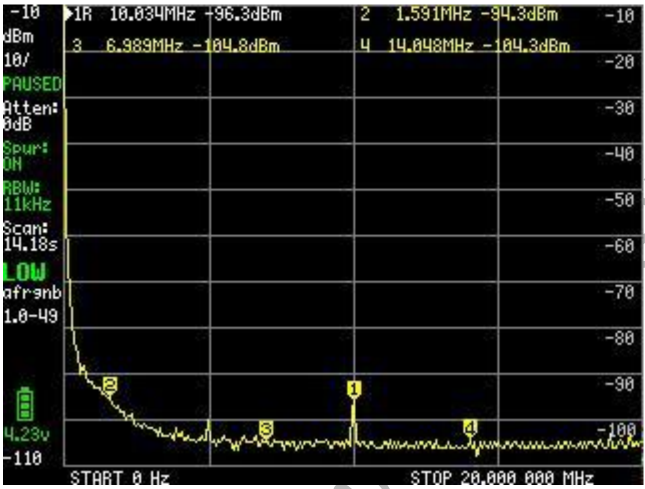


TinySA has an internal table that records at what frequency the IF must move to eliminate some of the spurs. This method of avoiding irritation has no negative impact on performance.

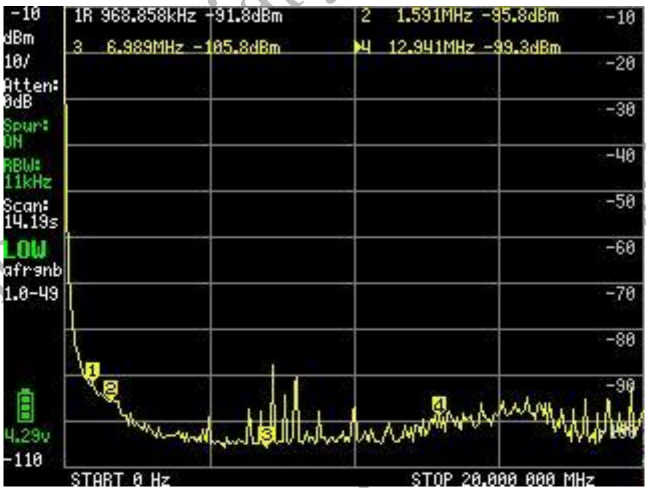
There are also spurs that are still present and can be reduced by spurious reduction techniques that really affect the scanning speed and the ability to measure transients. The scan below was done with SPUR removal enabled



This results in an almost clean noise floor. To check if the same scan has no effect on sensitivity when a 95MHz-10dBm signal is supplied



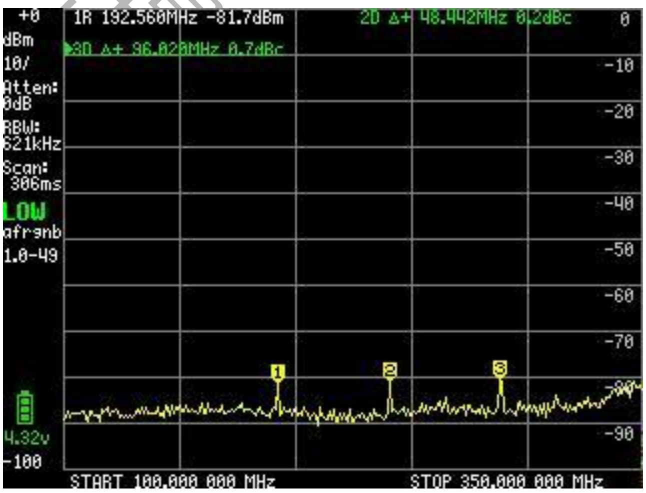
Measuring such a small signal is an art in itself, and it can be clearly displayed when both the signal generator and the TinySA are connected to a PC using their USB interface



Always make sure there are no ground loops, use a good quality cable, and tighten the SMA connector.

Inevitable glitches

However, there are some spurs that cannot be eliminated because they are actually present as input signals. An example is the 48MHz MCU clock harmonic leak, which can be seen in the scan below



These harmonics become stronger when telescopic antennas are connected, and since they are real signals, they cannot be eliminated by spurious removal.

Calibration menu

The calibration menu can be used to update or reset the level calibration of the TinySA

- The calibration begins with the actual calibration. The results are automatically saved in NVM
- Reset Calibration Resets the calibration data.
- Return to the configuration menu.
- Calibration is used to calibrate the level of power measurement. Before starting calibration, use a short SMA cable to connect the low input/output and the high input/output. Once the cable is connected, activate the calibration.
- The calibration can be reset by resetting the calibration.

At the end of the calibration switch of the TinySA. When plugged in again, the number indicating the power level should be white to indicate that the power reading is calibrated. The non-calibrated status is indicated by a red level indicator. Level calibration data is stored in the level offset configuration variable.

High Frequency Input and Output - TinySA

High-frequency inputs

The HF input menu is very similar to the LF input menu, except that it lacks functional options that are not present in the HF input, such as:

- Attenuator-related settings
- Mixer IF-related settings
- Bandpass filter measurement options
- Track output options
- Spurious reduction related settings
- There are many things to keep in mind when using high-frequency inputs
- The input IIP3 is -15dBm, so it is easy to overload.
- The leaf end is a direct IQ mixer with very limited image rejection (30dB max)
- To make the best use of high-frequency inputs:
- Set display/scan accuracy to "Accurate"
- If possible, disable Configuration/Expert Configuration/AGC.
- For low-level input signals, you can enable configuration/expert configuration/LNA (only used when AGC is disabled)
- Make sure the input signal is kept below -20dBm to avoid overload.

High-frequency output

The high-frequency output mode works very similarly to the low-frequency output mode, but with the following differences:

- The output is a square wave rich in harmonics
- The output can be set to various levels from -38dBm to +13dBm
- The frequency can be set from 240MHz to 960MHz.

- There is no level change function
- There is no AM modulation

附件四

Appendix III: Upper computer controls TinySA and TinySA Ultra

Connect to your computer

The USB interface of TinySA can be operated in two modes.

- USB to Serial Mode (Console Mode)
- DFU mode

During normal operation, USB to serial mode (also known as console mode) is active. DFU mode is used only when updating firmware. For this, please refer to the Bilibili video for updating firmware.

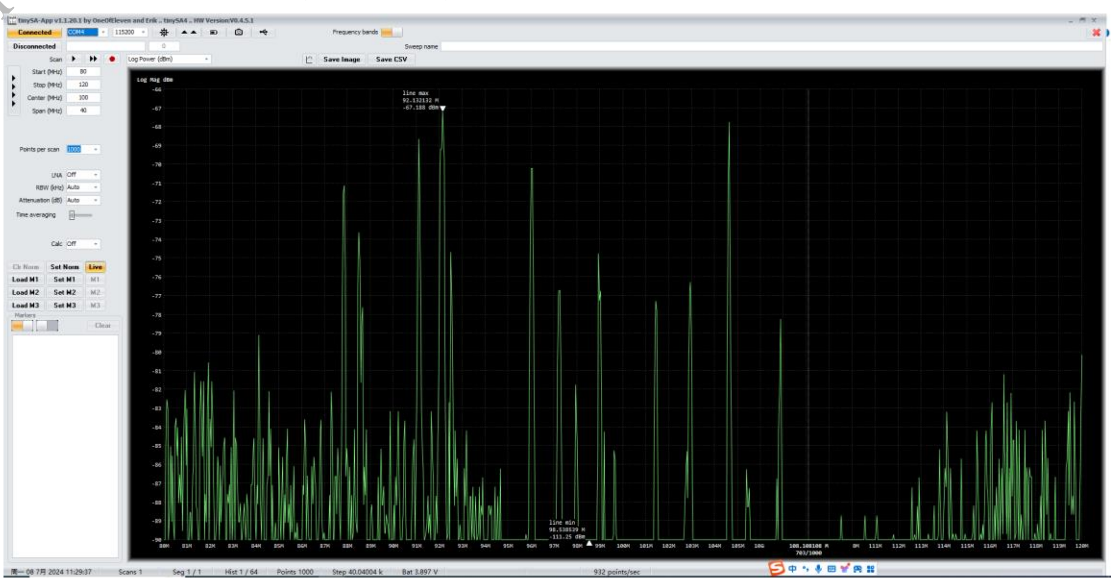
The USB to serial mode driver is built into Window10 and Linux, and currently does not provide support for Win7, so there is no need to install the driver. Simply connect TinySA to your PC using the included TypeC-USB cable.

Once connected, you can use the serial terminal program, which is currently open serial commands, or you can use a PC application to control TinySA.

There are three types of software to control TinySA. All are able to capture TinySA's screen

TinySA-App

TinySA-App is a Windows-based application developed by Erik himself on the basis of Nanovna-app, which can control TinySA and TinySA Ultra.

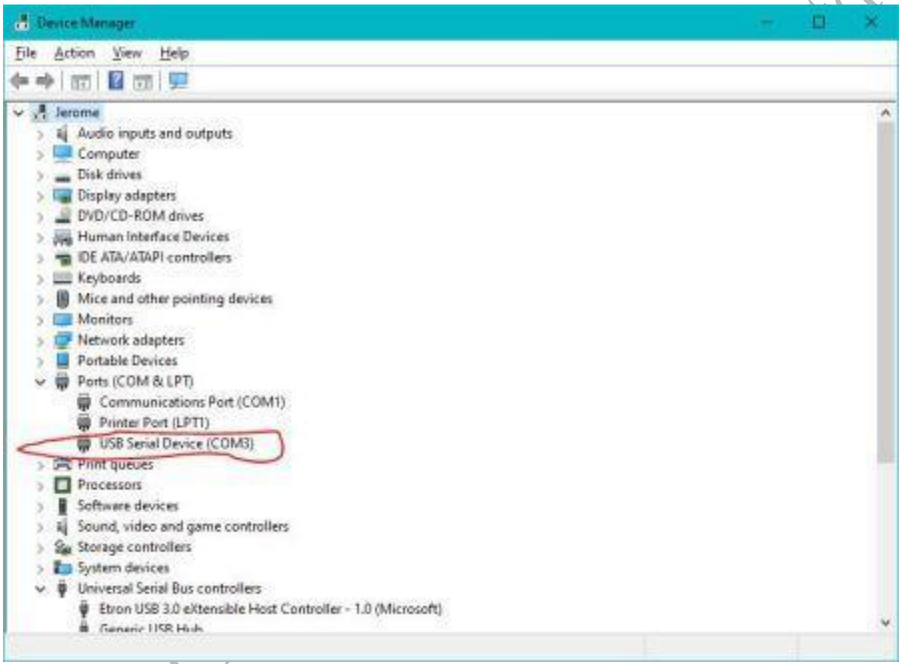


The executable file can also be downloaded from Baidu Netdisk:

Link: https://pan.baidu.com/s/1Pw8IUImyIvtcwsUkTD7zTg?pwd=nhyi

Extraction code: nhyi

If you can't connect to TinySA, please open Windows Device Manager and see if there is a new "Com" port device when connected to TinySA, and it will disappear when it is closed, then the new Comport is the Com port we need to connect. If "Unknown Device" appears, right-click on the unknown device, then click "Uninstall Device", and switch it back and on again until a new Com port appears.!! Win7 does not currently support direct connection.



Click "Disconnected" in the upper left corner of the TinySA-App, if it can be converted to "Connected", it means that the upper computer and the lower computer are connected normally. Then you can set the start frequency, end frequency and other parameters, click the single arrow next to "Scan" for a scan, and the double arrow for a continuous cycle scan

附件四

Annex IV: Measurements

IQ signal balance

In SDR TX/RX, the IQ balance of the LSB/USB TX can be checked with TinySA using the 2.7kHz test tone. TX is soft rock and LO is set to 7.1MHz, which is equal to TX, to create a worst-case setting. The frequency range of the TinySA is set to 20kHz

Unadjusted, it looks like this

Marker 1 is the required USB and Marker 2 is the LSB that is not needed

After some tweaking, it already looks even better

However, due to the noise on the left side of the TinySA resolution filter, an offset below -35dBc is only 5.4kHz.

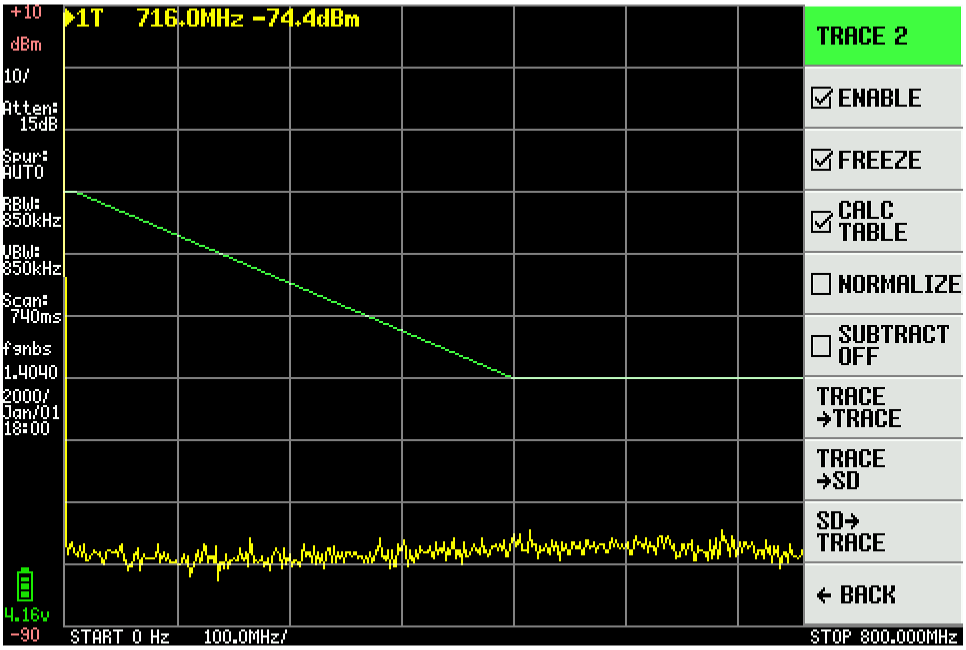
This can be solved by moving the TX frequency from the Softrock LO to 5kHz, which shows that we are not done yet. The range is increased to 50 kHz.

Adjust the IQ balance a bit to divert unwanted sidebands to noise below -40dBc

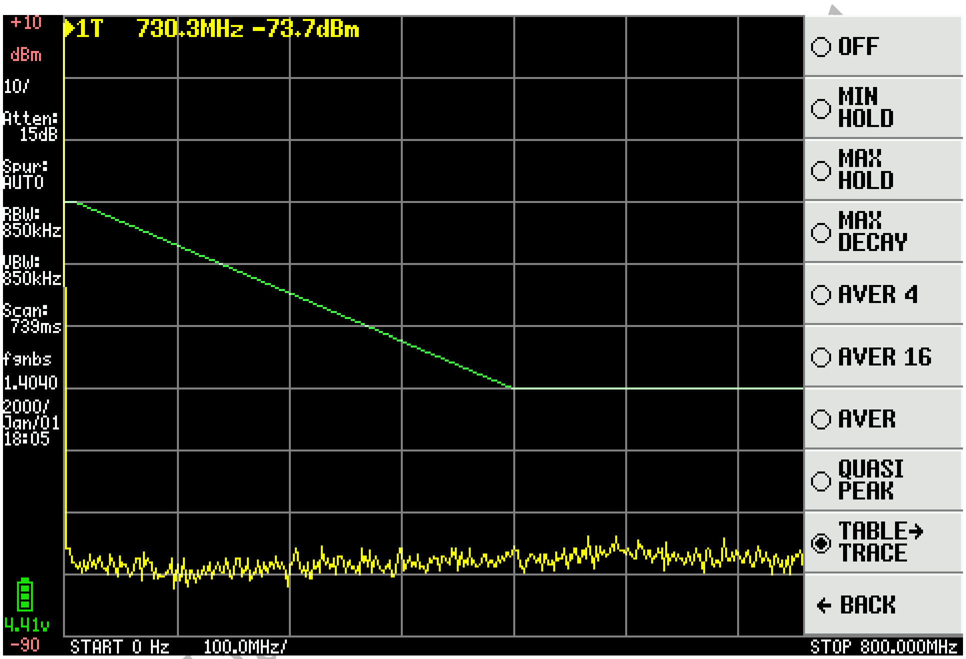
There are still quite a few LO leaks (Mark 3), but this can't be fixed with IQ Balance Tuning.

Limit Line

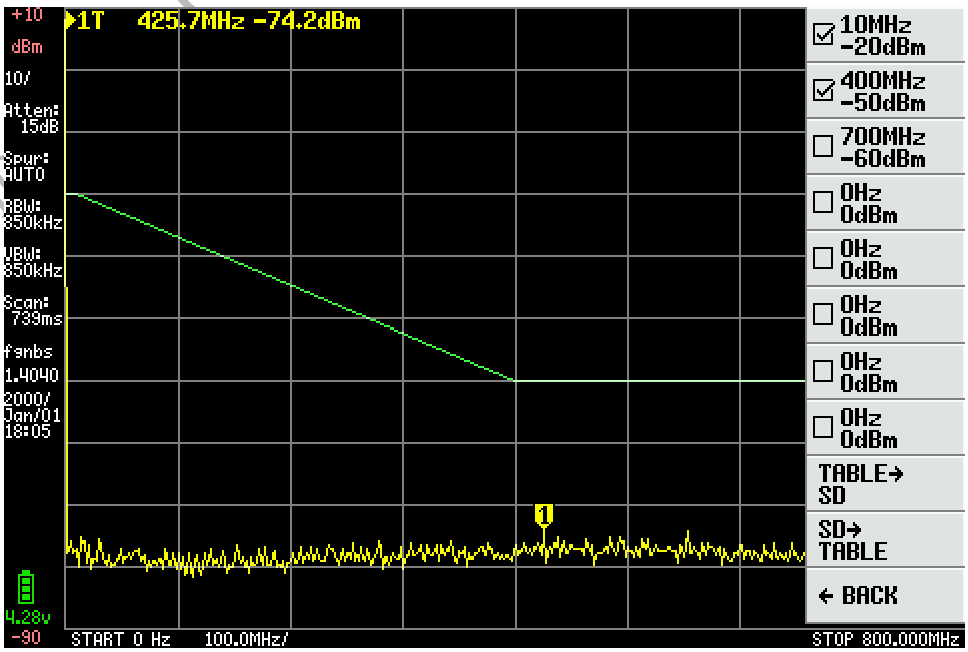
Select the trace you want to use to display the limit line, in this case, trace 2



Enable compute/trace tables



and enter a value for the limit line



There will be a horizontal line from zero Hz to the first active entry, and a horizontal line from the last active entry to the end of the scan range.

Entries must be sorted by frequency

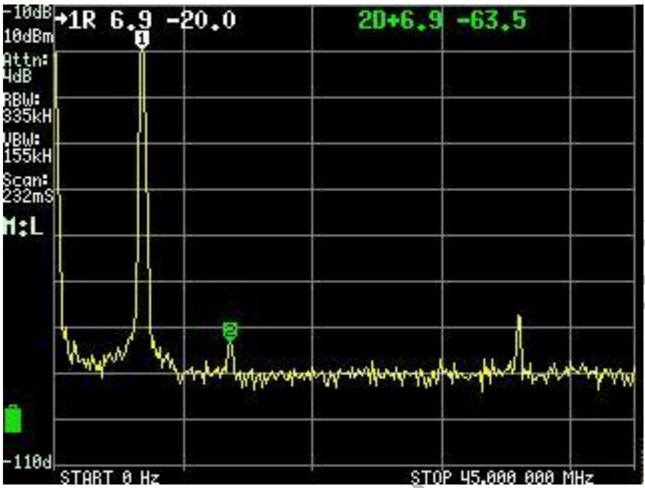
Spur Free dynamic range

No spurious dynamic range

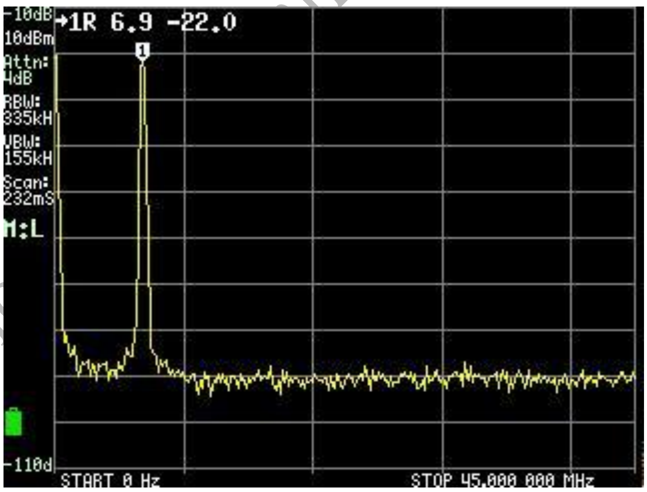
When measuring the spectral purity of a transmitter, it is important to understand the spurious-free dynamic range (SFDR) of the TinySA. This SFDR determines the lowest harmonic level that can be measured with TinySA.

Start with a fairly clean signal around 7MHz. The second harmonic is -2dBc

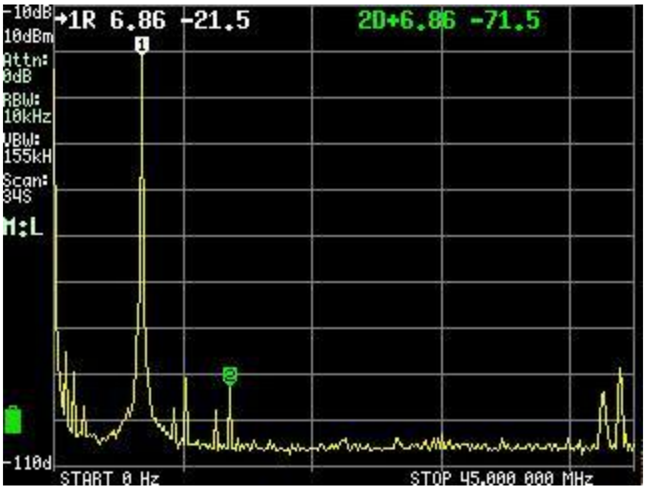
附件四



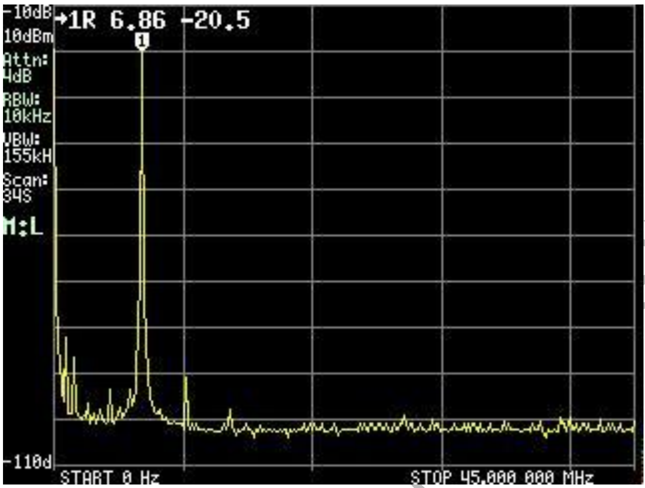
A low-pass filter is inserted between the transmitter and the TinySA to eliminate the second harmonic, and in effect it disappears into the noise



RBW is lowered to reduce the noise floor. The second harmonic is now visible again at -2.71dBc



And add a little attenuation to check if the remaining second harmonics are produced internally.



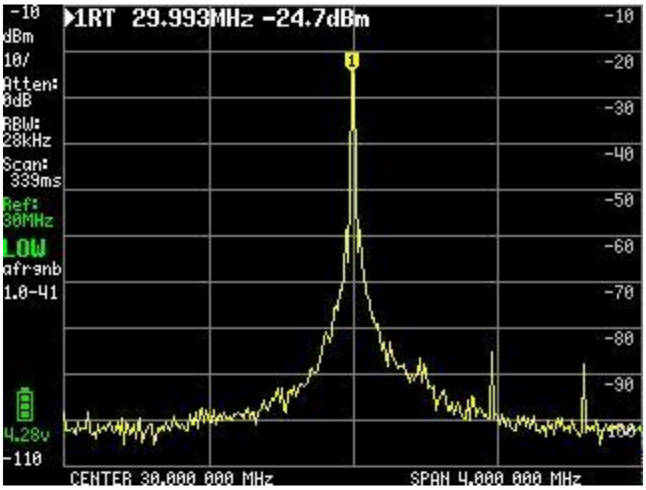
When the level of the second harmonic moves downward, it is generated internally. With this 2dB attenuation, the second harmonic is now below -4dBc, which is the maximum SFDR for TinySA.

Tuning Sweep Adjust the scan settings

Adjust the scan settings

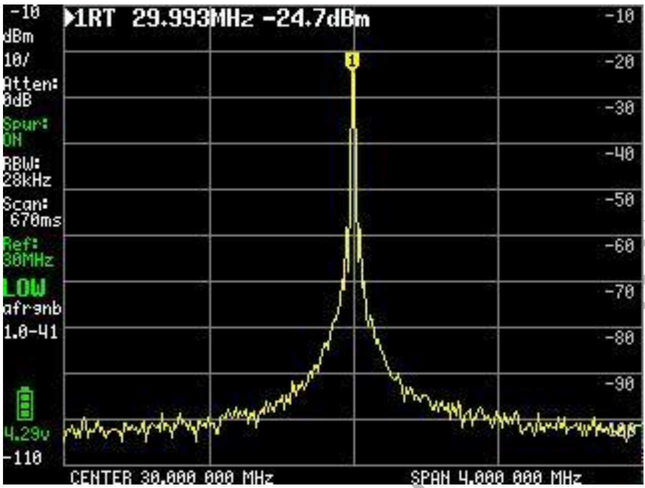
Depending on the various tiny SA settings, the time to perform a scan can vary between less than 20 milliseconds and more than 100 seconds. Here are some measurements with different settings to demonstrate their impact on the scan time

The fundamental wave of the 30MHz cal output is measured first, spanning 4MHz, with all other settings defaulting to <>MHz.



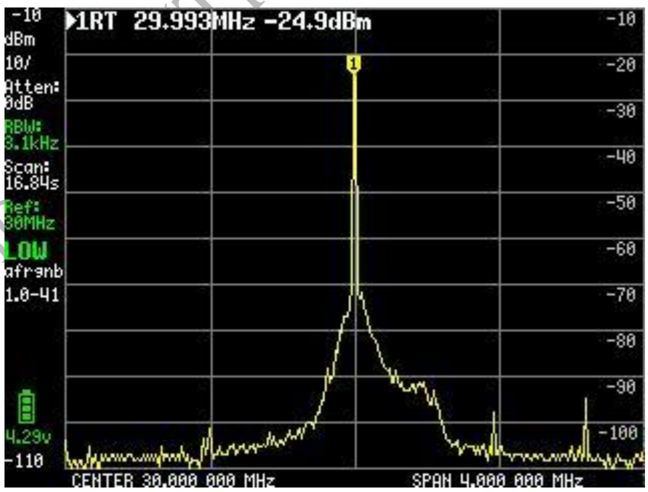
The important number to note is the indicated scanning time. In this case, it's 339 milliseconds

Sometimes small signals can be seen, and enabling SPUR removal will help identify if these signals are real or not



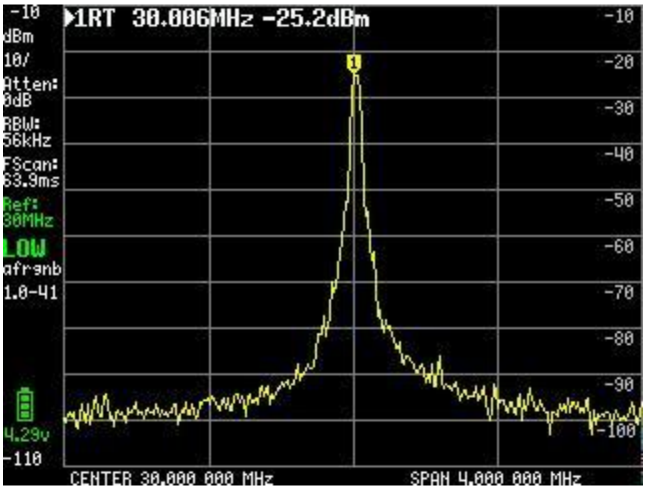
Since the small signal is no longer visible, these artifacts are created internally. Note that removing the SPUR doubles the scan time.

If the noise level is too high, the RBW can be selected manually, for example selecting 3kHz will reduce the noise level by almost 10dB



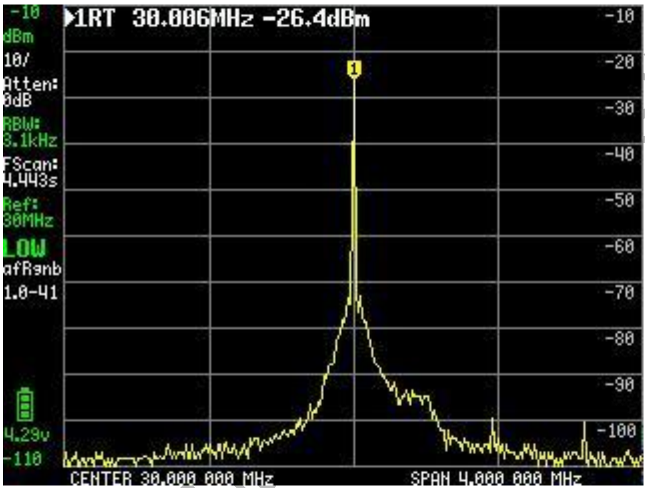
Note that the scan time is increased to 16.8 seconds because smaller RBWs need to measure more frequencies and take longer measurements per time.

One of the ways to reduce the scanning time is to choose the FAST scan mode. This creates more noise



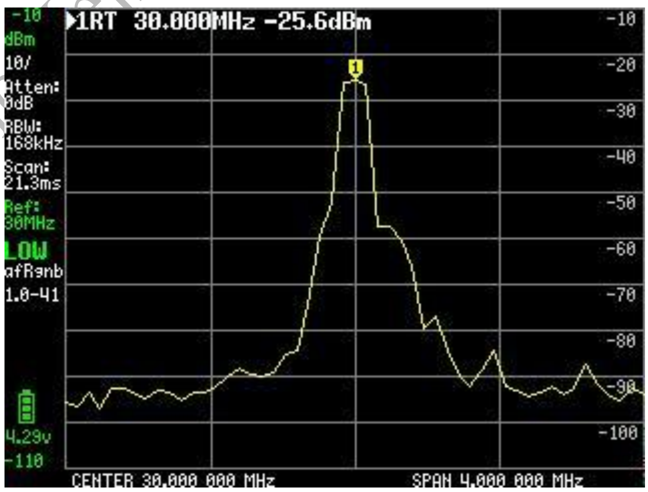
This fast scan takes only 63 milliseconds, which is about 4 times faster than the default setting. Another disadvantage of FAST scanning is the reduced accuracy of level measurement, as you can see in all FAST measurements on this page.

Especially when choosing a smaller RBW, it is important to reduce the scan time.



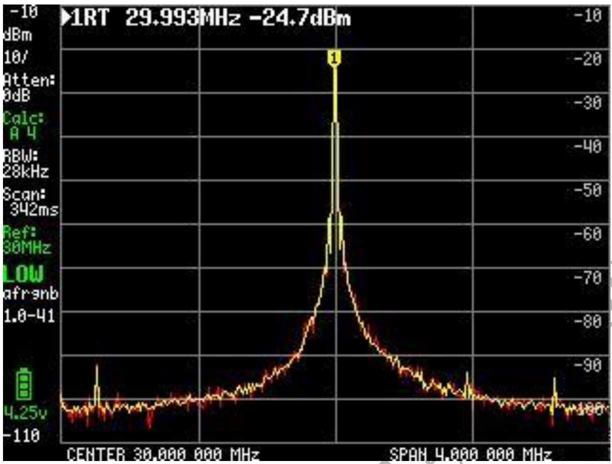
Again, about 3 times faster than a normal scan with a 4kHz RBW

Another way to reduce measurement time over small frequency spans is to reduce the number of measurement points. For example, there are only 51 point measurements.



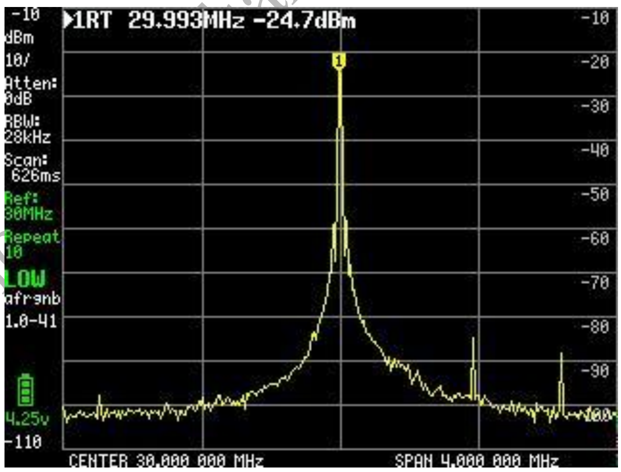
Notice reducing the number of points increases the automatic RBW selection from 28kHz to 168kHz but reduced the scan time to only 21ms. Ideal for tuning some circuit or filter

Reducing noise is possible by averaging. This can be done on a per sweep basis showing both the actual sweep and the averaged sweep using the AVER 4 option



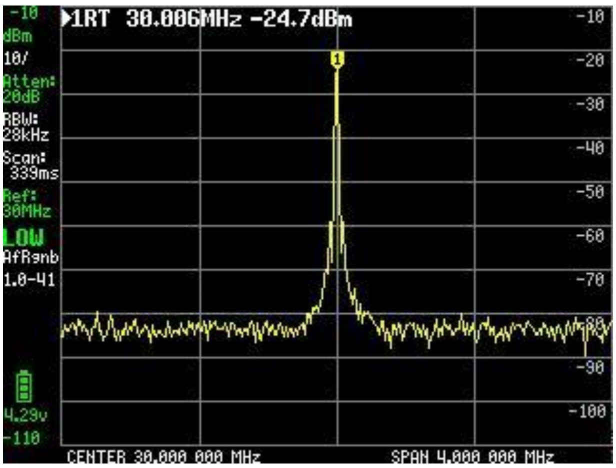
This setting does not impact scan time but it may take some sweeps before a change in level is reflected in the calculated yellow trace.

Another way to reduce noise is by setting the SAMPLE REPEAT to above 1. Setting the sample repeat to 10 give almost the same improvement compared to the AVER 4

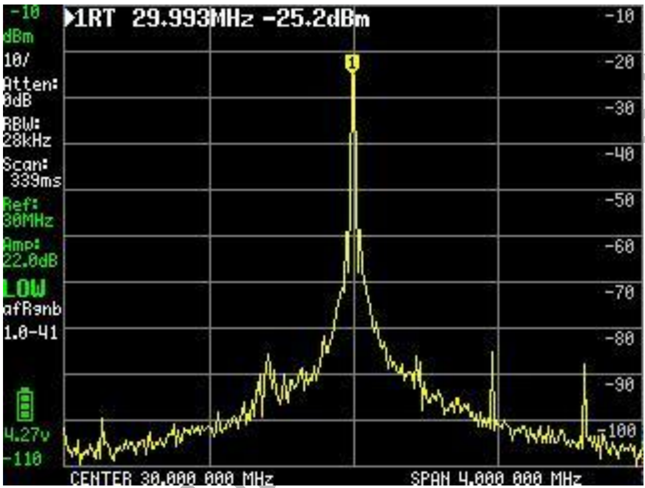


Since the sample is repeated multiple times to measure each point, there is some delay in between, and the scan time will increase

The selected signal at -25dBm is well below the maximum input level, and 0dB attenuation is selected for autoattenuation. For stronger signals, the attenuation level will automatically increase. The effect of this increased attenuation can be seen by manually setting the attenuation to a higher level (e.g. 20dB).



As a result, the noise floor rises by 20dB, but the signal level measurement does not change
Since there is sufficient margin, a low noise amplifier (LNA) can be added before the TinySA. With 22dB LNA, the noise floor should drop significantly, but this noise reduction does not occur due to the phase noise of the PLL and the noise generated by the CAL output



USB Command:Correction

correction table

There are two user-controllable level correction mechanisms in TinySA:
The first is the level offset, which is frequency-independent and can be set by doing a level calibration or using the actual power menu.
The second mechanism is the frequency-dependent correction table. There are two tables, one for low input and one for high input. Each table has 10 entries for frequency-dependent level correction.
The default table for the V0.3 hardware low input contains these values

slot	frequency	value
0	10000	6.0
1	100000	2.8
2	200000	1.6
3	500000	-0.4
4	30000000	0.0
5	140000000	-0.4
6	200000000	0.4
7	300000000	3.0
8	330000000	4.0
9	350000000	8.1

The current content of the table is displayed by entering a correction low without any parameters.
You can modify the data in the table by specifying the slot number and a new value.
Example: Corrected low 5 10000000 -0.5
This command will set Slot 5 to 10MHz, corrected to -0.5dB. The frequencies specified in the table must be sorted by increasing frequency. Make sure to execute saveconfig after the update to save the new values to the flash memory so that they survive the reset.

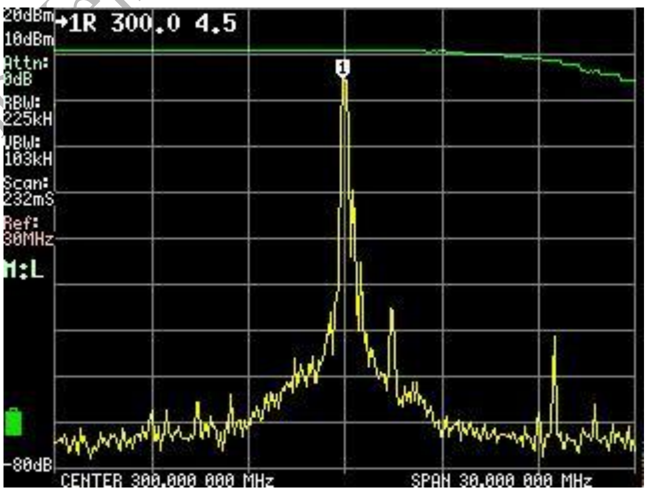
For 30MHz, there must be an entry in the low meter and the correction for that frequency must be zero. You are free to choose which entries to choose, as long as the table is sorted with increasing frequency

use of corrected table

All level measurements will use the measurement frequency to find the applicable correction.
Any frequency below the frequency in slot 0 will use the correction of slot 0
Any frequency higher than the frequency in slot 9 will use the correction of slot 9
Any frequencies between frequencies will use frequency-based linear interpolation to calculate the applicable correction
The correction table for the high input sets the frequency value, but all corrections are set to zero.

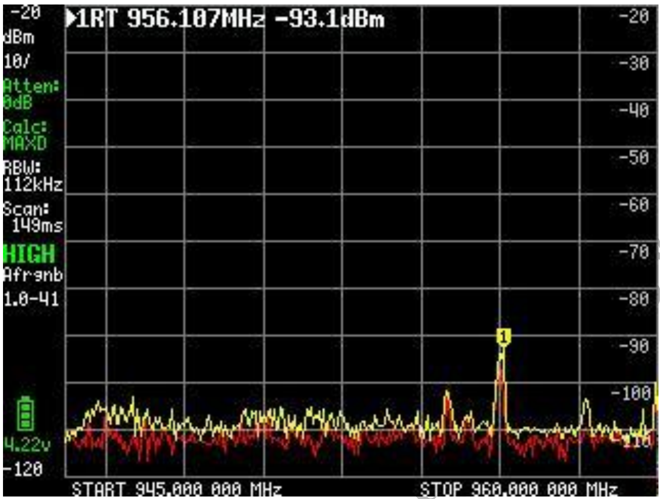
Compression point

The 1dB compression point can be easily measured using an internal attenuator and linear measurements to step through 30 attenuation steps and plot the peak level measured at all steps. The green line here plots 11 measurements of the 300MHz signal at +290dBm, while on the left is 30 1dB attenuation steps with the highest attenuation (29dB). The line shows a 1dB compression point of about +3dBm. In this level, there are some differences between tiny SAs.



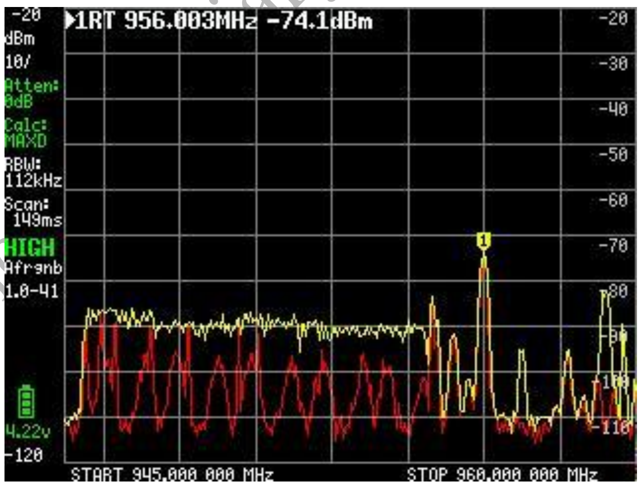
Coaxial cable shock

If there is no coaxial cable connected to the high input, the power enclosure near the cell phone base station can be seen using only the maximum attenuation



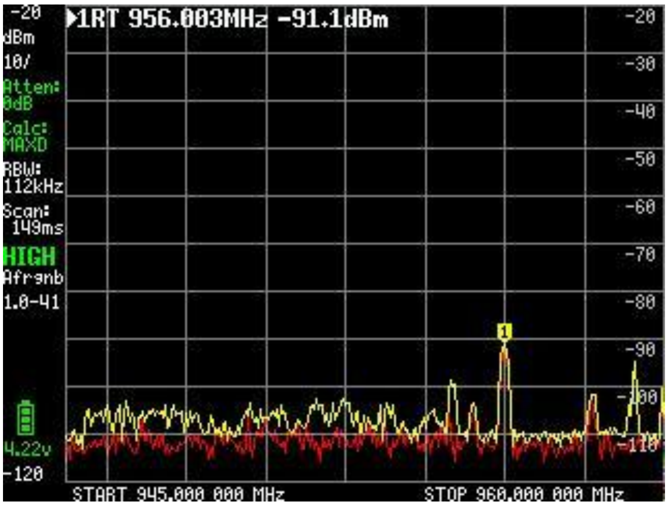
The signal under mark 1 also comes from the mobile phone base station.

Changes occur as soon as one of the included coaxial cables is connected to the high input and the other end is left open



The signal below the power envelope and markers increased by almost 20dB

Replacing the supplied coaxial cable with a double-shielded coaxial cable, which costs more than the TinySA, indicates that the shielding of the supplied coaxial cable is not perfect, as the power envelope is reduced to a level where (almost) no coaxial cable is connected.



因此，请注意，许多同轴电缆远非完美。

附件四

Add LNA manually

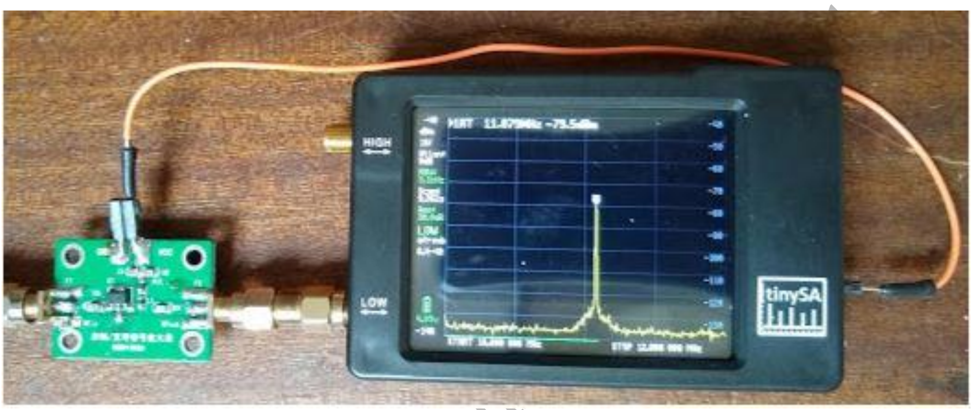
Sometimes you need a higher sensitivity while still being portable. This can easily be done with a small modification to TinySA

Start by soldering a single DuPont female connector to one of the Vdd points on the edge of the PCB.

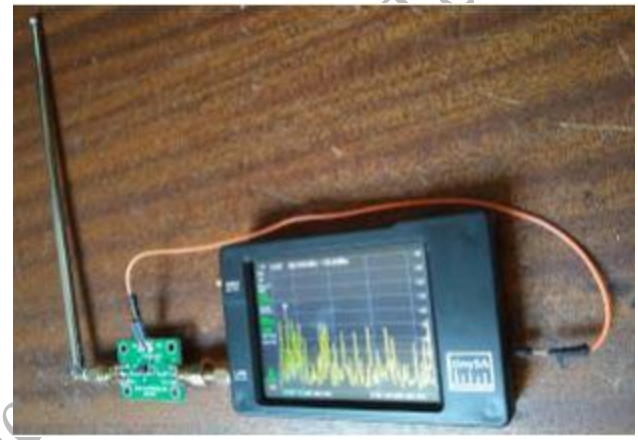
Warning: The maximum current consumption is 100mA. Monitor the temperature of the tiny SA and turn it off if it's hot. Drawing too much current can ruin your tiny SA

The next step is to make a small hole for the DuPont connector and put the tiny SA back into the housing.

When connected to an inexpensive LNA, this LNA provides 30dB amplification without noticeable noise, and with the RBW set to 3kHz, the noise floor is up to -135dBm and the -80dBm signal is clearly visible. Note that the level/external amplifier settings are used to meet the amplification of the application, so the displayed level is still correct.



Combined with a small telescopic antenna, the TinySA is ready for some QRM hunting

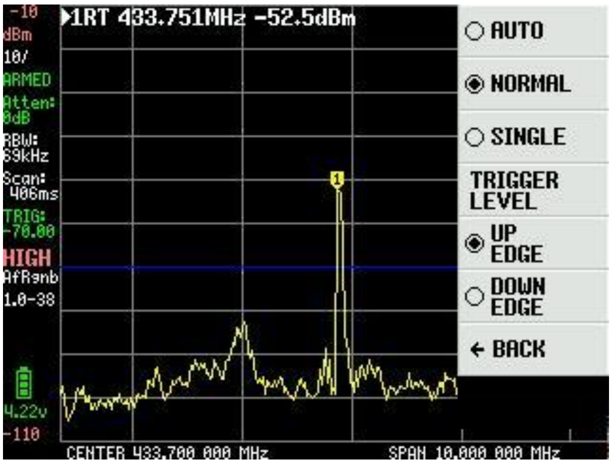


Capture OOK ISM signals

Many open-key ISM have short transmission times. Great for seeing if TinySA's trigger feature is useful.

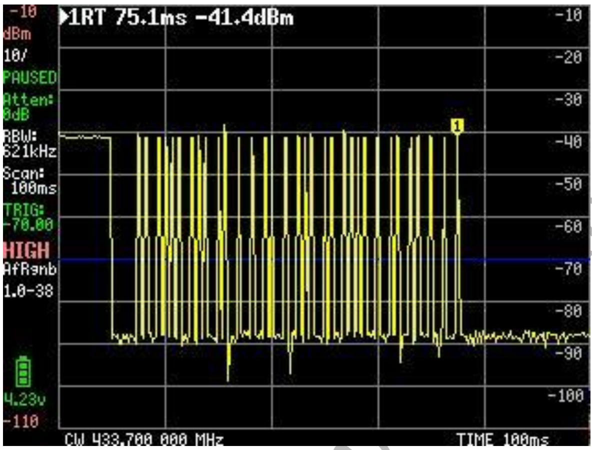
Start by setting a wide scan of around 10MHz to 433MHz to find the frequency of the transmitter

The trigger level is set to -70dBm, the trigger mode is set to normal, and the signal is captured using a telescopic antenna connected to the high input

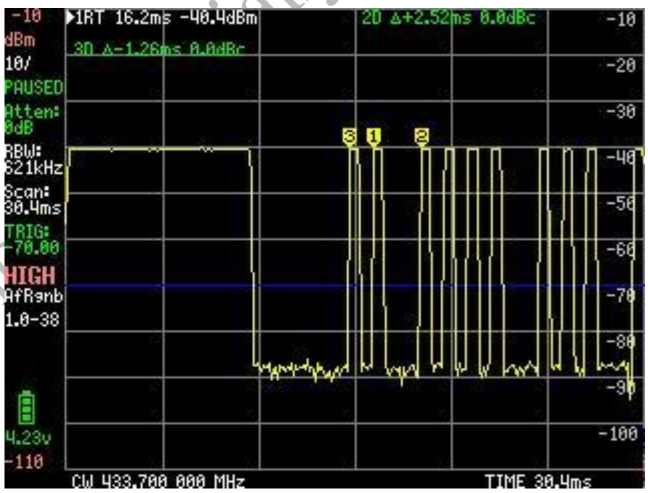


You can see in the status panel that the trigger is armed, so any new signals are automatically displayed

Now that the frequency is known, we set the TinySA to zero-span mode and try to capture the entire transmission with a single trigger and a scan time of 100ms



After a single trigger occurs, the status changes from "armed" to "suspended"
In order to gain insight into bit timing, the scan time was reduced to 30ms

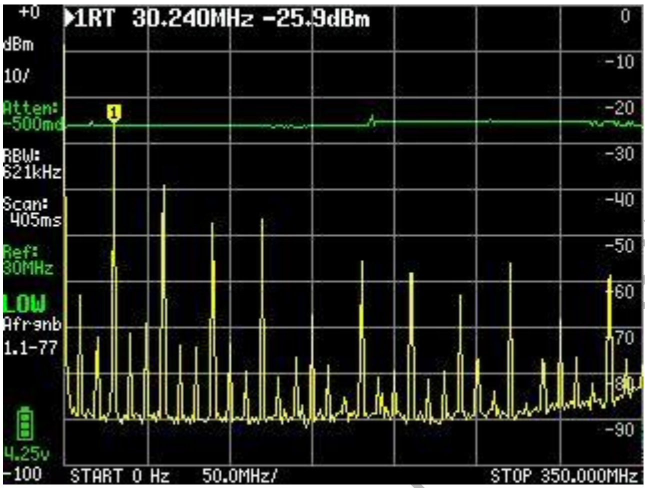


Using the marker in incremental mode, the discovery bit timing is 1.25ms

Check the internal attenuator

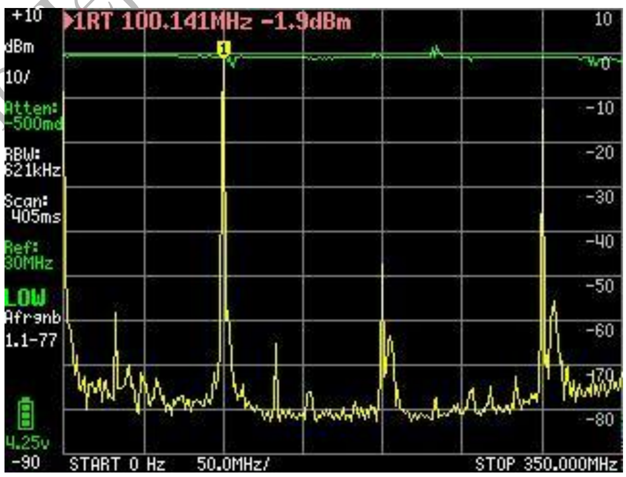
Check the attenuator

Start by connecting the high and low connectors using one of the included SMA cables
Turn on TinySA and enable the 30MHz CAL output with the command MODE/Cal output/30MHz
Returns low input
Use MEASURE/MORE/LINEAR to activate the linearity test, which will cause the built-in attenuator to iterate through all attenuation values and draw a green line on the screen where the signal level is measured. If all goes well, the line should be flat within +/- 1dB, with occasional deviations from the measured value due to interference/noise



If you observe a deviation of more than +/- 1dB in the green line (excluding some noise/interference), please post a readable picture or screenshot of the completed linearity test on the TinySA support group

The test also helps to gain confidence in the 1dB compression point of the TinySA. This can be measured by applying a signal of 0dBm and activating the measure/more/linearity test When the attenuation is below 2dB, the compression starts and is visible in the green line that bends a little downward on the right side due to the compression.

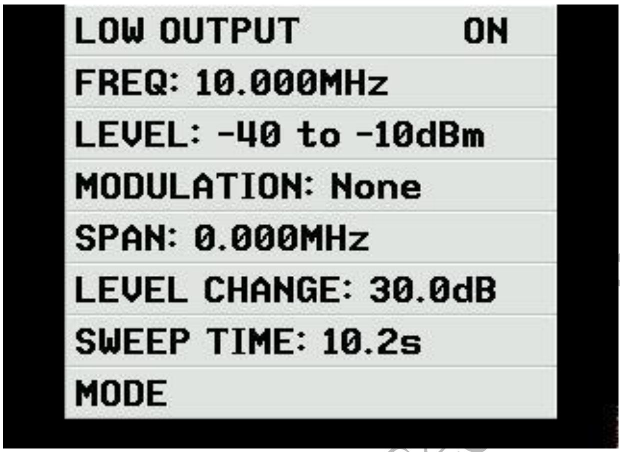


Measure the 1 dB compression point of the amplifier

To avoid over-steering of the amplifier, it is best to know the 1dB compression point. This is the input level at which the amplifier output is 1dB below what it should be.

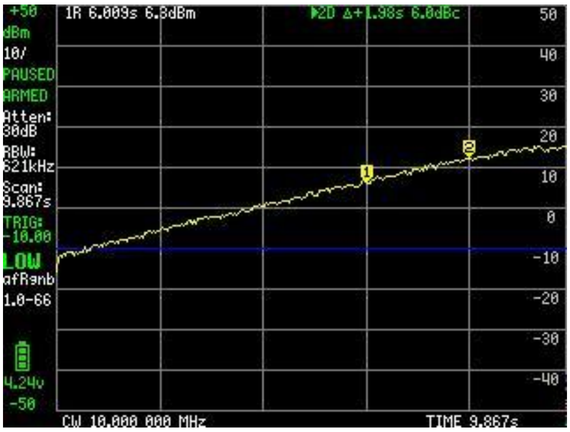
Measurements often require multiple measurements at different signal levels. It was a good challenge for TinySA.

The first part of the setup is the signal generator that provides a level sweep. The tiny SA settings are as follows



The frequency is 10MHz and the output level changes from -10dBm to -2dB in 40.10 seconds
The output of the generator is connected to the input of the amplifier, and the output of the amplifier is connected to another tiny SA. The second TinySA is in low input mode, set to zero-span mode at 10MHz, with a scan time of 10 seconds and a normal drop trigger of -10dB level as shown below

When the signal generator jumps back to -40dB, the second TinySA triggers and starts recording the level for 10 seconds. Using two markers (a reference and an increment marker), it is easy to see that the level increase for each cell is 6 dB (5 cells, 30 dB total)

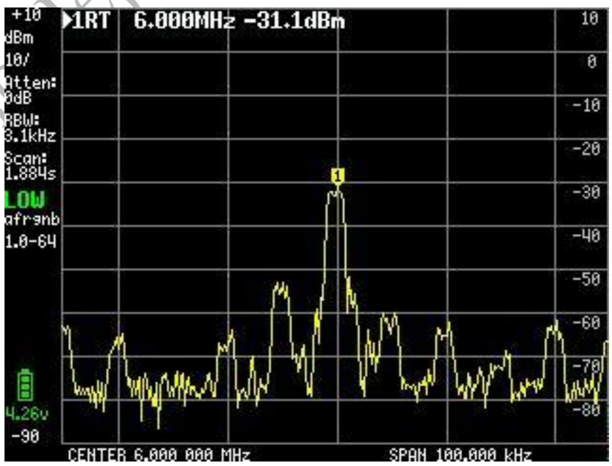


Then move the marker to the right to a position where instead of adding 3dB per half, only 2dB is added.

The amplifier's output 1dB compression level is 13.8dBm at mark 2, and the amplifier's input level of -40dB plus 9 times 3dB (or -10 minus 3dB) at that point equals -13dBm. Keeping the amplifier's input below -13dBm will ensure no compression.

Measure AM modulation

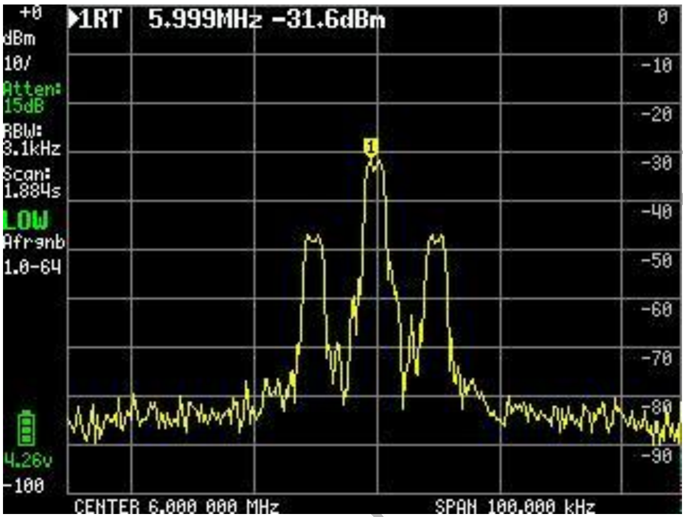
TinySA has some issues when measuring AM modulation. This is clearly visible at 100kHz wide scan below 10kHz and 50% depth AM modulated 6MHz signals.



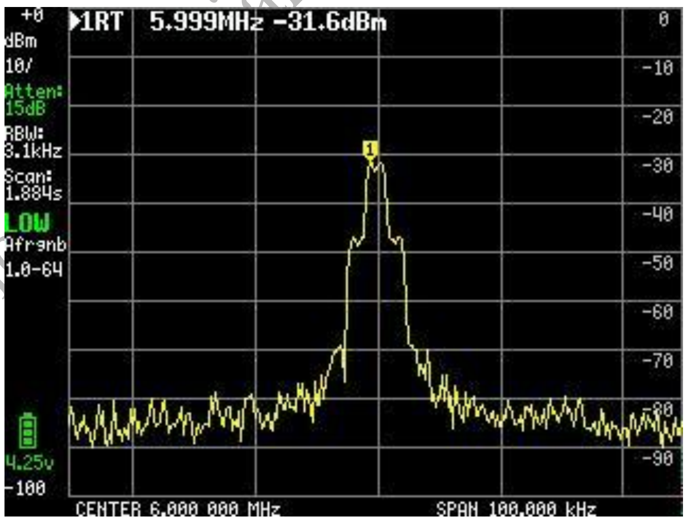
This strange effect of many signals is caused by a completely failed internal AGC. You must ensure that the level of the input signal carrier minus the internal attenuation is below -45dBm by manually increasing the attenuation.

Increasing the manual attenuation creates a better image

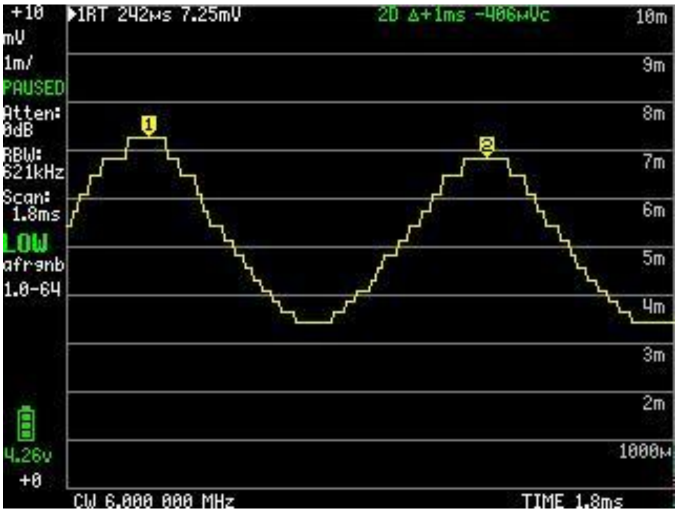
附件四



The lower limit of modulation that can be observed in frequency mode is indeed 3kHz at a minimum RBW of 3kHz



For lower modulation frequencies, it is advisable to enter a zero-span mode (time mode) and a linear unit to show the signal strength as a function of time, where 50% of the modulation depth can be clearly observed

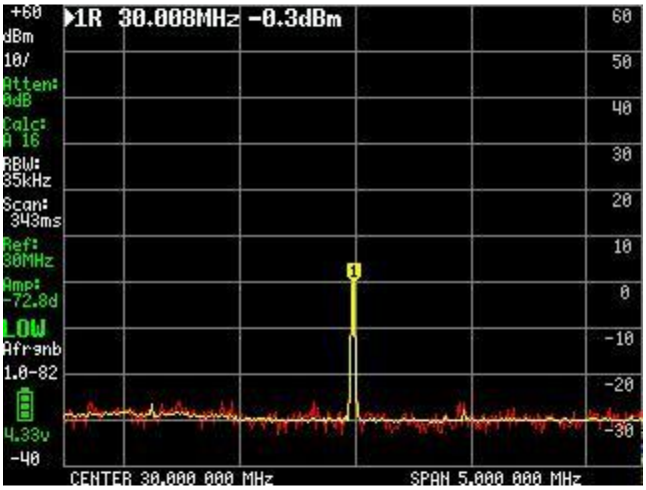


Measure the Noise Feature

Measure the noise figure of the amplifier

In addition to gain, OIP3, and 1dBc, noise figure (NF) is an important metric for amplifiers, so we want to know the NF of the amplifier being used.
NF is the dB decrease in post-amplifier SNR compared to pre-amplifier. This means that we have to measure the noise level.
For this measurement, we need some attenuators and two amplifiers, the LNA and the amplifier under test (DUT). LNAs are needed because the noise figure of the TinySA is too large to directly observe the noise contribution of a single amplifier.
The first step was to normalize the TinySA to the test signal level that we wanted to use to measure the gain of the two cascaded amplifiers. To do this, we hooked up a number of attenuators with a total attenuation of about (+/- 10dB), which is equal to the total amplification of the two cascaded amplifiers to the calibrated output. We set the calibration output to 30MHz (or any other frequency we want to use) and observe the calibration output level attenuated by the attenuator. Make sure that the tiny SA internal attenuation is 0dB. We then set the external amplifier to the same value as the observed signal level. After that, the signal should be read as 0dBm.
The measurement setup looks like this

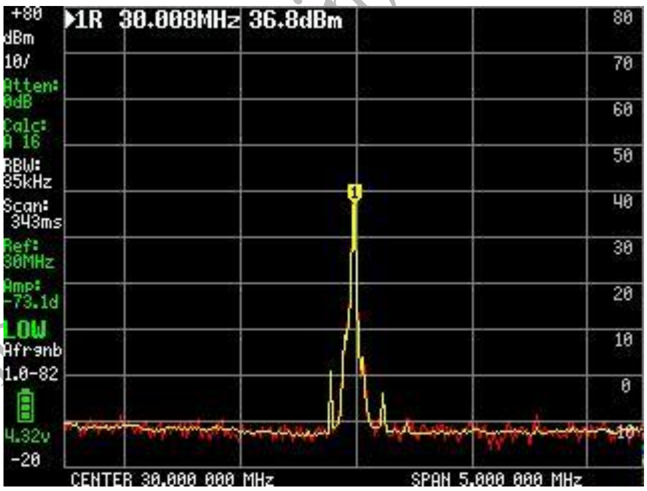
The normalized measurements are shown below (its +0.3dBm i.s.o. 0dBm)



附件四

Now we insert the amplifier between the attenuator and the input of the TinySA as shown in the image

We can read the amplification (36.8dB) of the cascade amplifier directly below the marker



Now let's make some changes

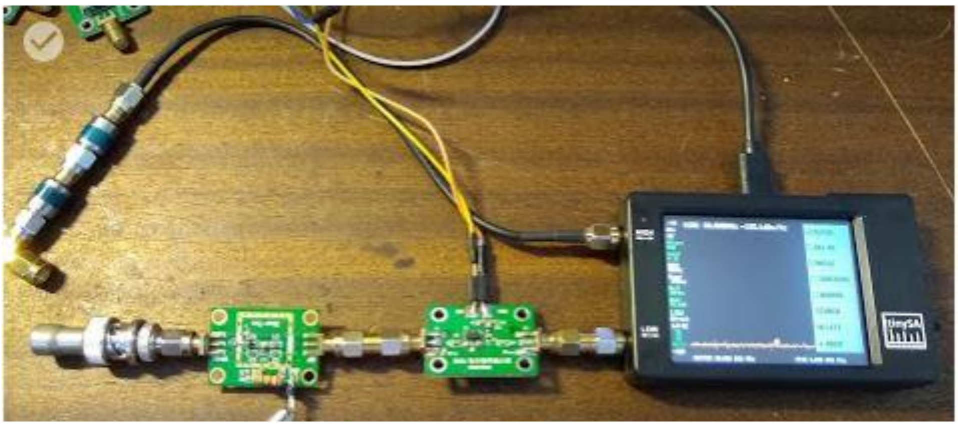
Set External Amplifier to Measure Amplification (36.8dB)

Decouple the attenuator from the input and terminate the first amplifier input at 50 ohms (you can also decouple the Cal output from the attenuator and use the attenuator as a 50 ohm resistor)

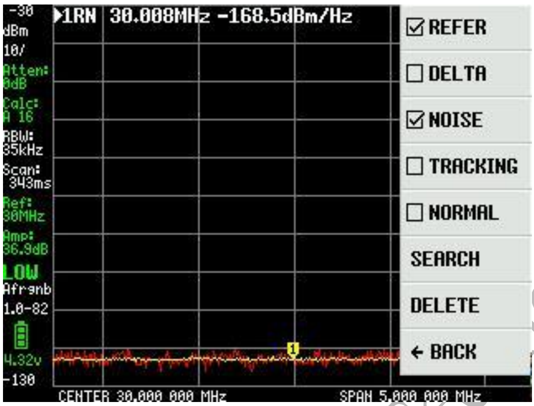
Sets the noise property of the marker so that its value is displayed in /Hz and is independent of the active RBW.

SET DISPLAY/CALC/AVER 16 TO GET THE MAXIMUM AVERAGE

The noise measurement settings are shown below



We can read the valley of the noise mark (-168.5dBm/Hz)



To calculate the noise figure of the first amplifier, we simply subtract -174dBm/Hz (noise power per hertz at a 50 ohm resistor at room temperature) to get a noise figure of 5.5 dB. The specs of the first amplifier give 4.5dB of NF, so we're close.

This measurement assumes that the gain of the first amplifier is sufficient to mask the noise of the second amplifier, and that both amplifiers will mask the internal noise of the TinySA, so we can safely ignore the noise of the second amplifier and the TinySA. To ensure that this masking occurs, the total amplification of the cascade amplifier must be higher than 30dB.

We can now also measure the noise figure of the LNA by interchanging the DUT and LNA, putting the LNA in the first place and connecting its output to the DUT. Since the amplification remains the same, we can measure the noise level directly using the noise markers. The measured noise figure of the LNA is between 0.5dB and 1dB, which meets its specifications

Measure PhaseNoise

Measure phase noise

When phase noise measurement is activated, TinySA asks for the frequency of the carrier used for phase noise measurement. The specified frequency is used as the center of the span. Next, you can enter the offset frequency for the phase noise measurement. Typical offsets are 10kHz, 100kHz, or 1MHz. The span of the TinySA is set to 4 times the offset, and two markers are activated. The first marker is the tracking marker, which is automatically positioned on the carrier. The second marker is an incremental marker that is positioned in low mode at the frequency of the tracking marker plus the specified offset. In high mode, the phase noise marker is located below the carrier to avoid mirrors of the carrier that could otherwise obscure the phase noise. Use this delta marker to display information in dBc/Hz for direct reading of the phase noise at the specified offset.

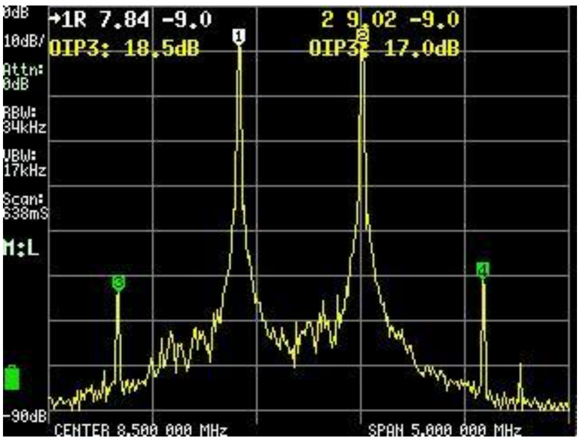
As mentioned in the limitations, the phase noise of the TinySA is not outstanding. However, a simple analog VCO can produce even worse phase noise.

The first is VCO. The phase noise is given in dBc/Hz with a 1MHz offset at mark 2

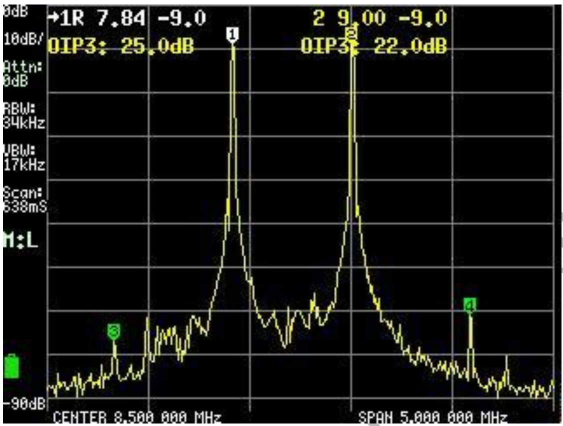
This is followed by DDS, which is better than TinySA, so this is the lower limit that can be measured.

Measure third-order intermodulation

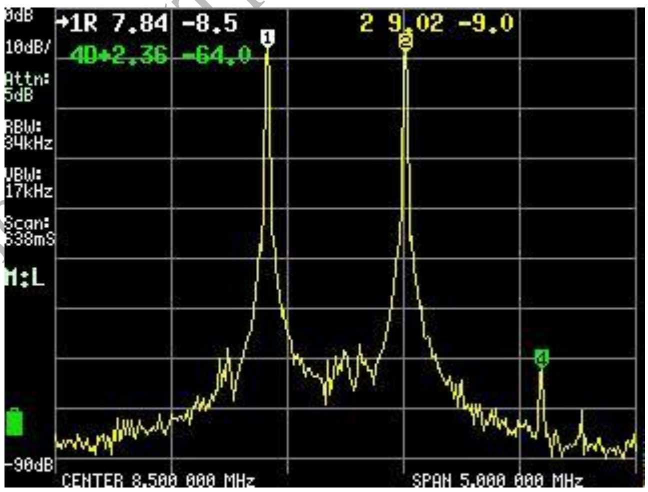
The measurement function of OIP3 can also be used to measure IIP3 of tiny SAs. This IIP3 is the lower boundary of OIP3 and can be measured by TinySA and depends on the attenuation chosen. As an input signal, we used a fairly decent sine wave of 8MHz and 9MHz from two different signal generators, combined into the TinySA's low input via two 6dB attenuators and a resistor combiner. The chosen -9dBm level is well below the 1dB compression point of TinySA's first mixer. With the LO driver set to the default level, attenuation to 0dB, and using the OIP3 measurement function, we measured IIP3 of about +17dBM



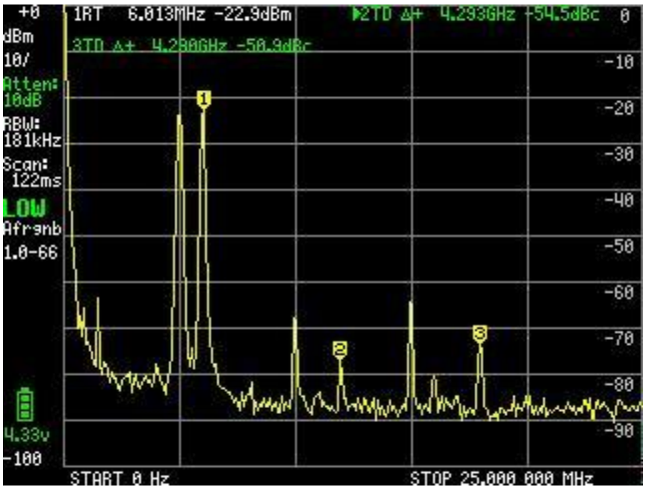
Increasing the LO driver to the maximum increases the IIP3 level of the left-hand intermodulation product to +25dBm, but the right-hand intermodulation product is still much worse at +22dBm



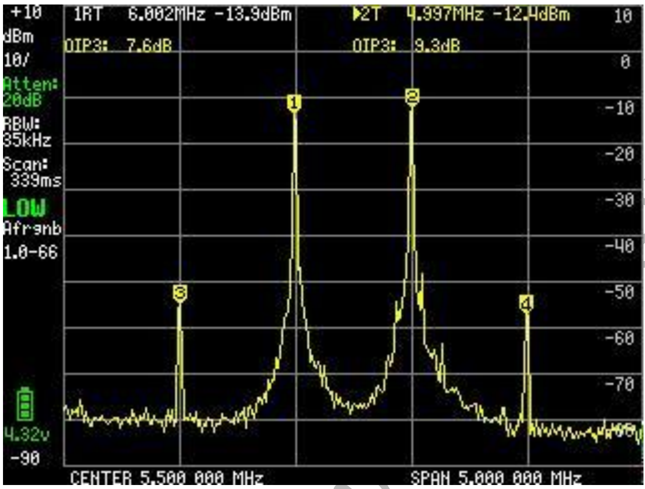
When we increase the tiny SA input attenuation to 5dB, the intermodulation product on the left disappears, so it is generated internally. The correct intermodulation product does not change, so it is present in the input of TinySA



Now that we know the IIP3 of the TinySA, we can start measuring the IIP3 of the amplifier. First, we use two tiny SAs to create a two-tone generator. These are the two tone outputs including harmonics.

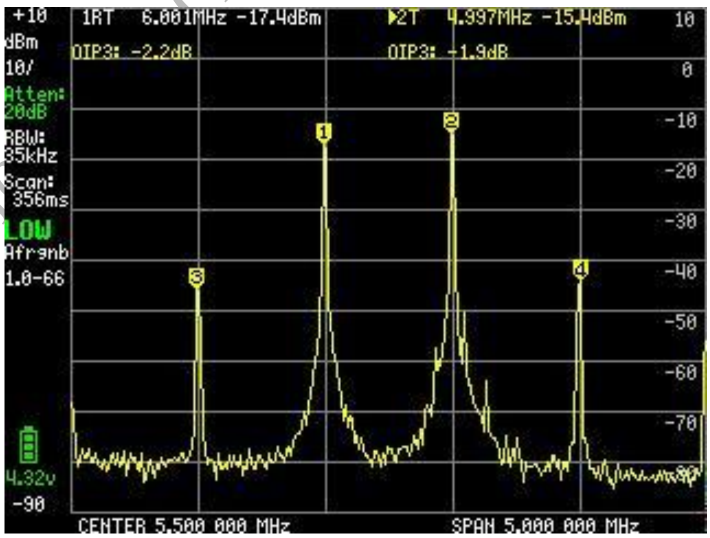


Despite the presence of attenuators between the tiny SA generator and the passive combiner, there is still some third-order intermodulation that can be seen when we look closely.



The OIP3 of this dual tone generator is about 8dB, so we had to carefully create a test setup to make sure this doesn't hide the amplifier IIP3.

Now we add the amplifier and a 30dB attenuator after the amplifier in the path between the two tone generators and the TinySA, and we get:

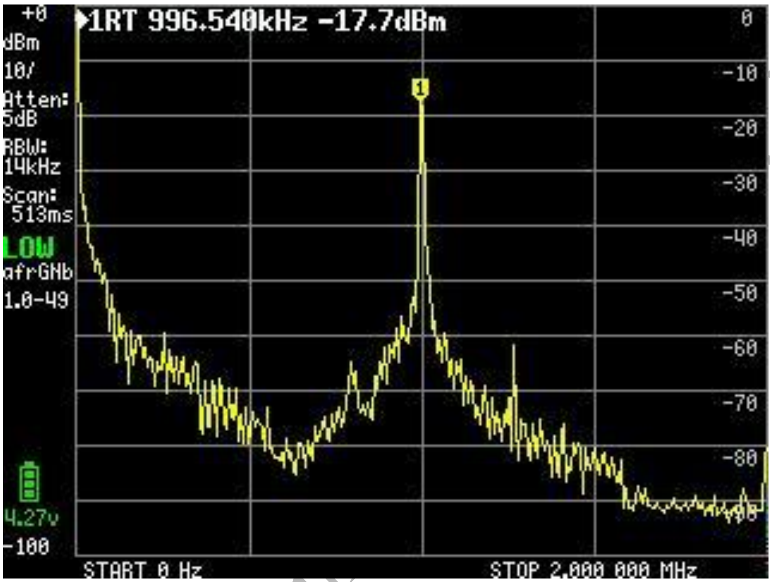


Since the signal level we observed was 3.5dB lower, because without the amplifier and attenuator, we would have to add 3.5dB to the measured IIP3, which is about -2dBm, so we get +3.1dBm of IIP5 amps. It's 6.5dB lower than what we measured without the amplifier and attenuator, so we can be sure that we're measuring the IIP3 of the amplifier.

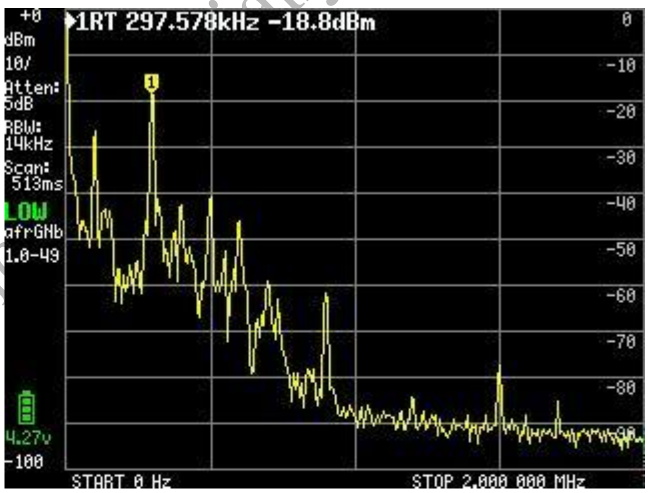
Measure low-frequency signals

When measuring signals below 1MHz, some annoying artifacts may appear.

The first is a fairly clean 15MHz signal at -1dBm

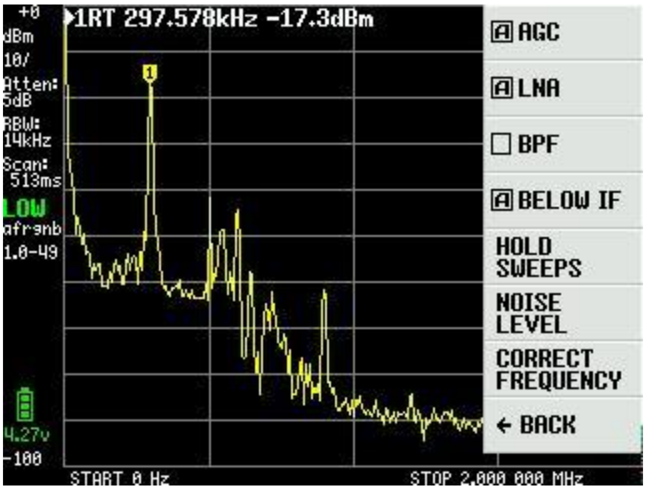


When we move the input signal to 3.15MHz at -0dBm, we get very different measurements



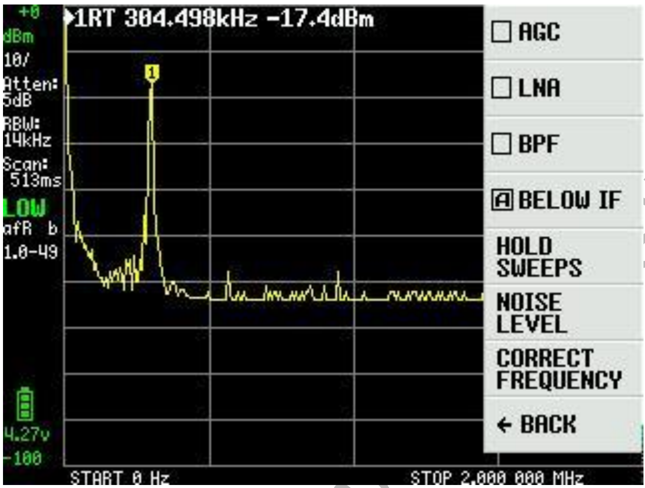
Artifacts are caused by abnormal behavior of AGCs below 0.5MHz. That's why in default mode, AGC is disabled below 0.5MHz.

Setting AGC and LNA to the default automatic settings would be improved.



The menu that appears is the second page of the expert configuration, showing that everything is in the default/automatic state.

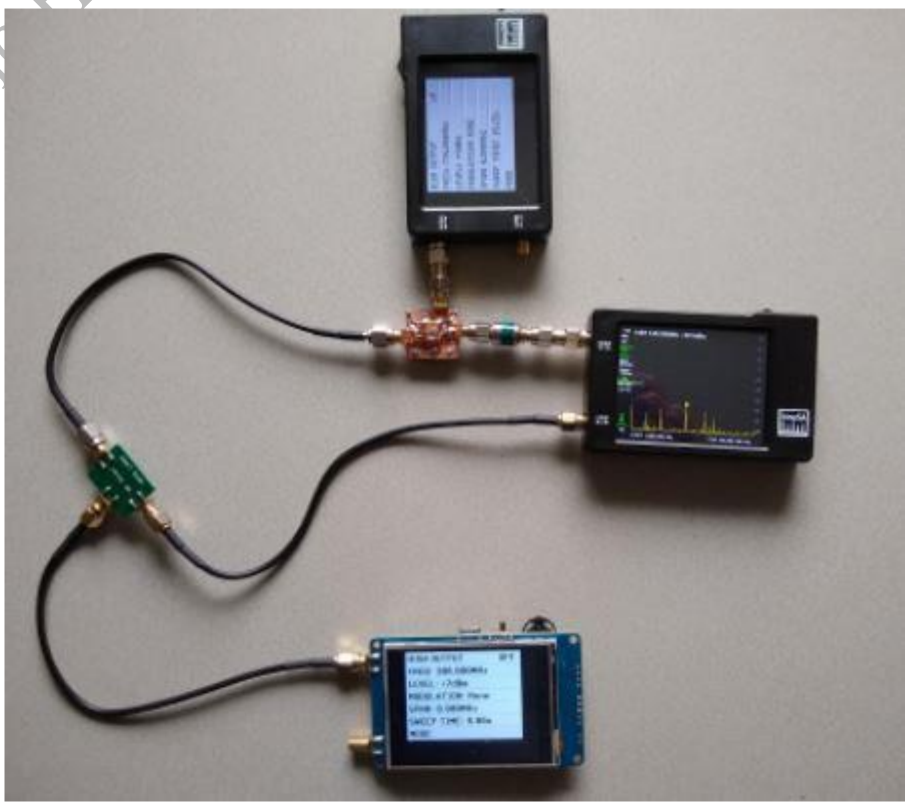
Since the signal is too strong for the LNA, it is advisable to switch LNAs as well



Measure the mixer

Using the LO output as an input to an external mixer, where the LO input is driven by the generator, you get a tracking generator that can track tiny SA scans at offset. This makes it possible to measure frequency conversion devices such as mixers.

The overall setup is shown below



In the lower left corner there is a green module with the mixer to be tested. The LO output of the TinySA on the right is used as an input to a copper foil-coated mixer via a 20dB attenuator to create a tracking generator. The tiny SA at the top is the LO of the TG mixer. The tiny SA at the bottom is the LO of the mixer under test

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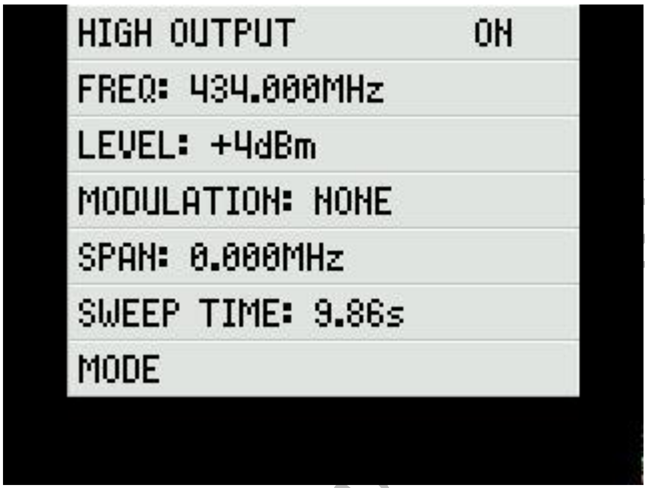
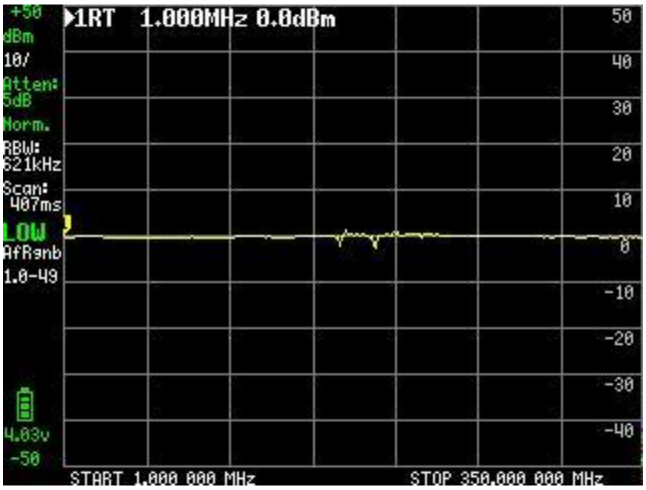
First, you set the tracking generator to a zero Hz offset as shown below

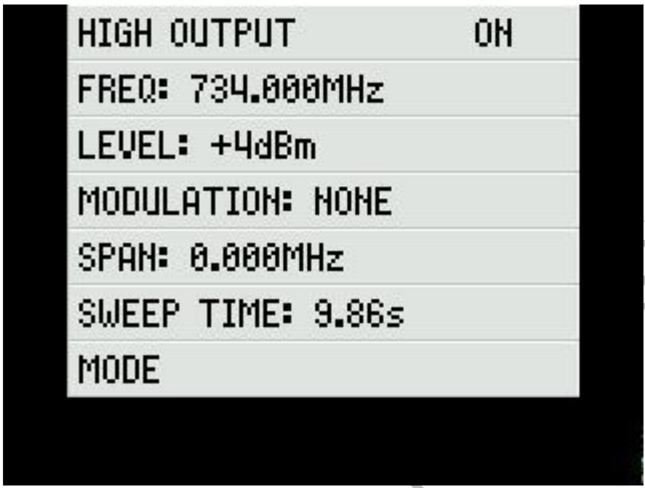


and establish a direct connection between the TG output and the SA input

standardization

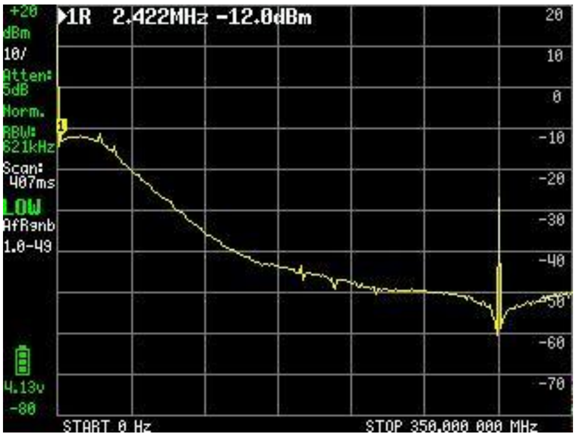


Then plug in the mixer under test as shown in the first image and set the TG to offset to 734MHz, resulting in a 300MHz offset



The LO of the mixer to be tested is enabled and set to 300MHz and +7dBm output, and the conversion loss of the mixer is obtained on the SA

The loss is about 8dB, which is well within specification.
But there were some problems with the second mixer

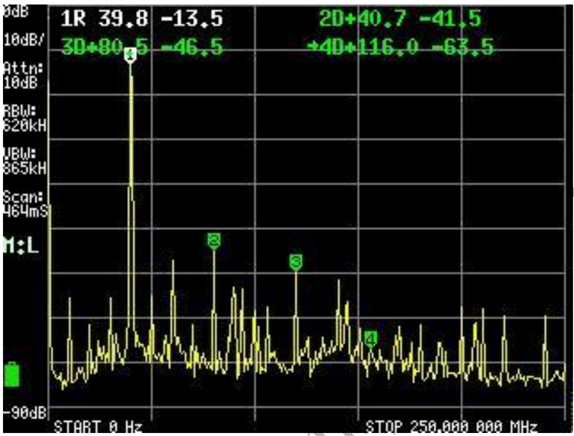


It turns out that the output impedance of the mixer under test is not matched correctly.

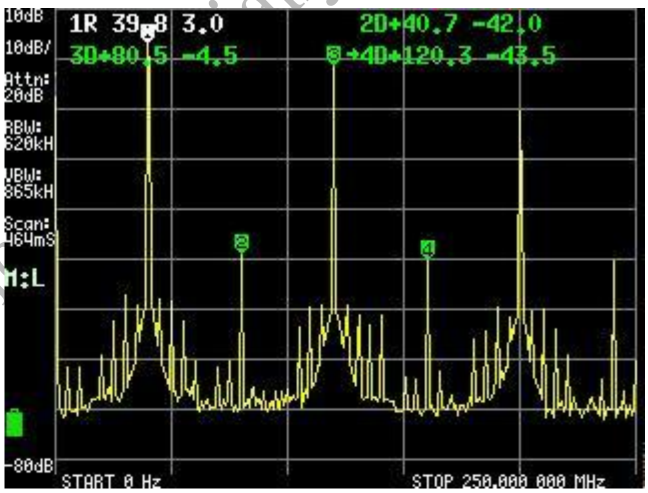
Measure harmonics

Before you start measuring harmonics, please note that you understand the spurious-free dynamic

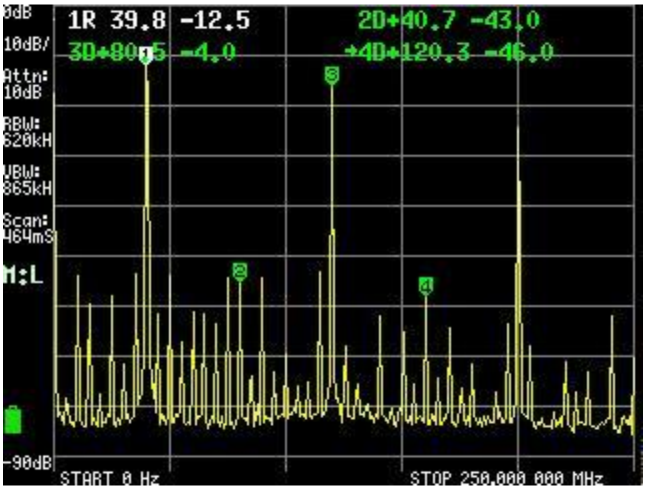
range and avoid input overload, keeping it as low as possible, preferably below -30dBm
Here are some examples of measurements of 40MHz signals from various sources
First from DDS



SI5351



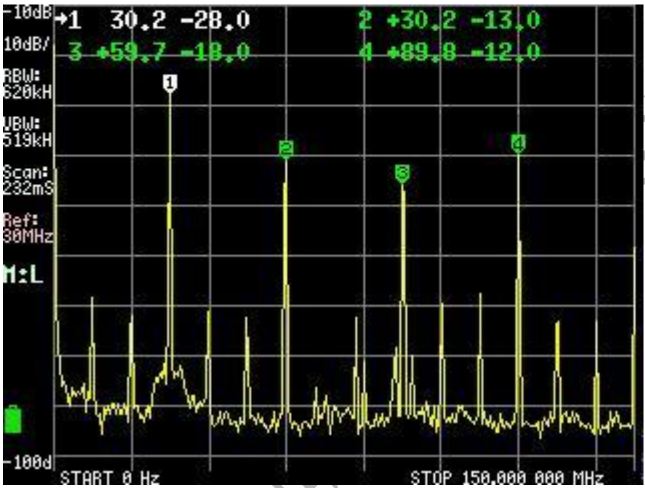
The third is from ADF4351



The difference between harmonics and aliasing and DDS is clearly visible.
These measurements are done by default at all settings, only the scan stop frequency is set to 250MHz
When harmonic measurement is activated, a keyboard appears for entering the approximate

frequency of the fundamentals. This is not necessarily an accurate number, as TinySA will search for the strongest signal

The IMD measurement screen appears next



Activate four markers

1. 1. Automatically find the strongest signal, which should be the basic signal, and the marker is set to the tracking reference marker
2. 2. Automatically find the second harmonic, and set the mark to the DELTA mark, and the level is displayed in dBc
3. 3. Automatically find the third harmonic, and set the mark to the DELTA mark, and the level is displayed in dBc
4. 4. Automatically find the 4th harmonic and set the mark to the DELTA mark, and the level is displayed in dBc

The fundamental level should not exceed -20dBm, preferably below -30dBm. If the signal is too strong, the attenuation should be increased. Since harmonics can occur inside TinySA, it is advisable to verify that this is not the case by changing the attenuation and to see if there is no effect on the harmonic level. Remember the incremental levels of various harmonics and increase the attenuation by 5 or 10 dB. Apply additional external attenuation in high mode. After the attenuation increases, the noise floor should rise, but the fundamental and all harmonics should remain at the same level. If harmonics drop, they are generated, at least partially, inside TinySA. If this happens, increase the attenuation until you no longer see the change, and use this attenuation level as the starting level for the measurement.

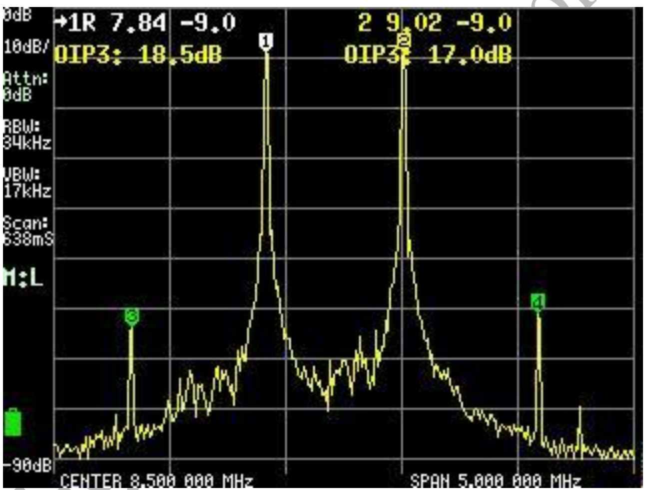
Since harmonics are multiples of fundamental frequency, the measurement range of the applied input mode limits the harmonics that can be measured. In low mode, the second harmonic can be measured up to half of the maximum low input frequency

The measurement output is third-order intermodulation

When the OIP3 measurement mode is activated, TinySA first asks for the first test signal frequency and then the second test signal frequency. TinySA then configures itself to be five times the frequency difference, with the center at the average of the two frequencies. The specified frequency does not have to be exact, but it must be within 20%. In the image below, the test signal on the left is specified as 8MHz, but it happens to be 7.8MHz

Since the phase noise of the TinySA is not very good, it is important to use two test signals that are preferably at least one MHz apart

Enable two normal tracking markers, which will be on the two strongest signals. Marker 1 is on the left signal and Mark 2 is on the right. Two incremental markers are also enabled, which are automatically positioned on the computed third-order intermodulation product. As shown in the figure below, the general information for labels 3 and 1 is shown, but the information for labels 2 and 3 is replaced by the calculated OIP4 level. Two numbers are given, one is calculated by the left intermodulation product and the second is calculated by the right intermodulation product.

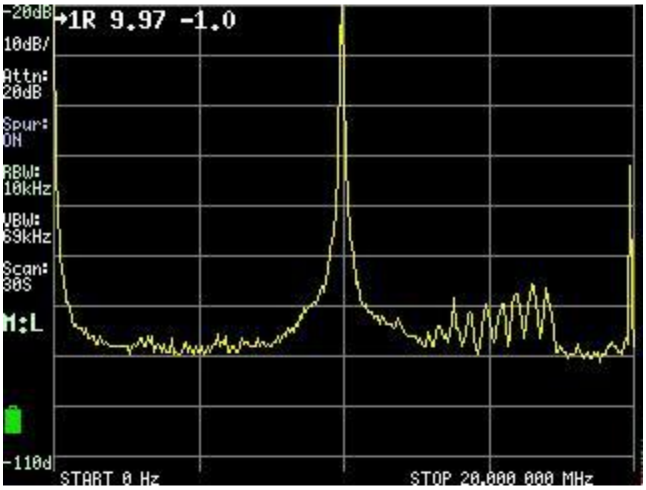


Attenuator settings are very important. At low attenuation, the tiny SA first mixer performance will most likely limit the maximum OIP3 that can be measured. Changing the attenuation amount should be noted to change the measured OIP3. If so, you should increase the attenuation until it is no longer so.

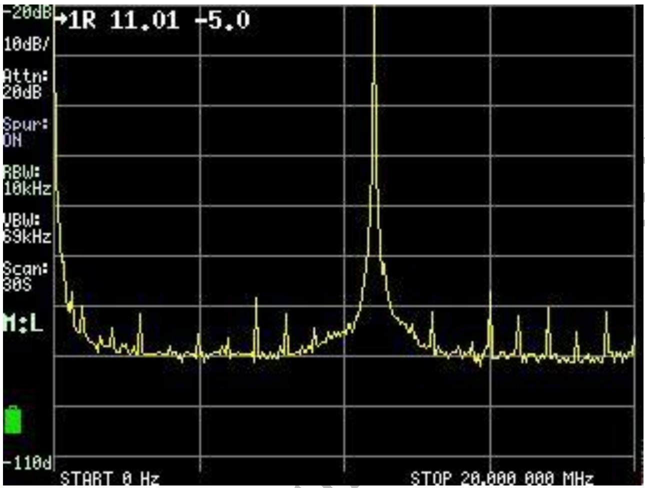
Spectral purity is measured

Here are 11 examples of checking the quality of a 3MHz signal. For these measurements, the RBW is set to 10kHz and the reference level is fixed at -20dBm to ensure that the noise floor is visible. In addition, the SI5351 is routed through a 10dB attenuator to obtain all 3 signals with comparable input levels. The attenuation remains automatic.

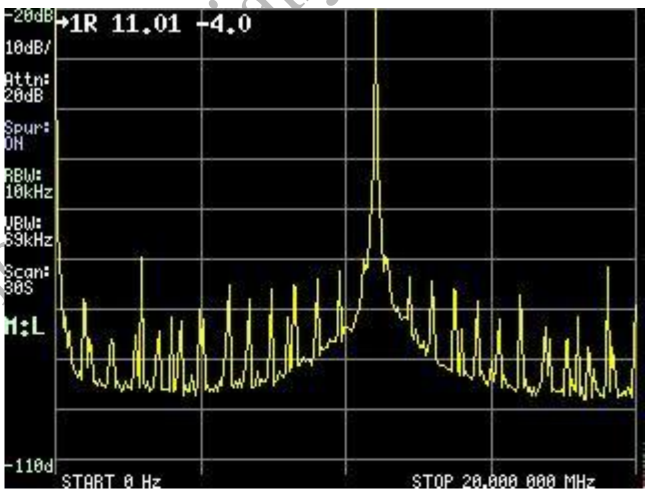
The first is the signal from an ancient analog signal generator



Interference around 15MHz is caused by signal generators.
The second signal is from DDS



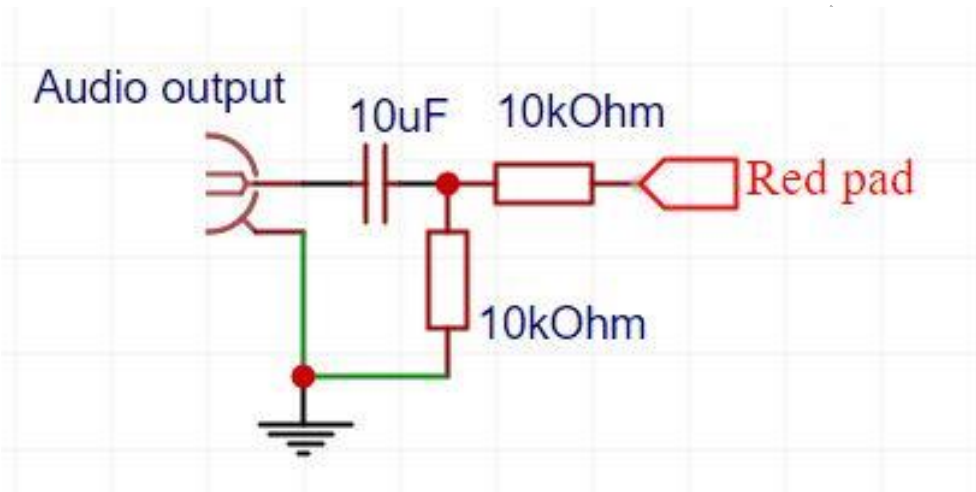
The third is the signal from SI5351



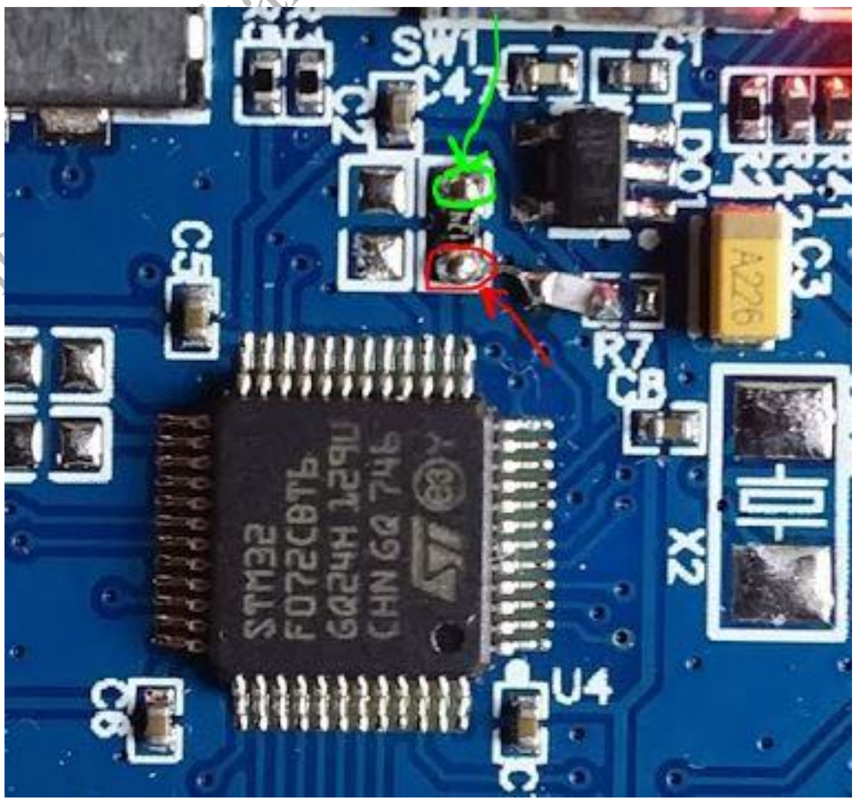
Keep in mind that the baseband signal is at least 15dB higher than the reference level. This shows the dynamic range of the tiny SA
As you can see on the screen, a full scan with this amount of detail such as low RBW and spurious reduction does take about 30 seconds, compared to less than 0.5 seconds for a 250MHz wide scan with the default settings. This is due to the insertion of 13 additional scan points per display point (see ratio of RBW and VBW) and the time required for the RBW filter to stabilize.

Listen to TinySA

With minor hardware modifications, AM/FM demodulation signals can be listened to in both low-input and high-input modes.
The audio output circuit provides DC isolation and some protection from the DAC output



The headphones can be connected directly to the audio output. If you need volume, move the 10k to the ground and replace the remaining 10k with 4.7k
The red pad connection is connected to a pad with a red circle on a tiny SA PCB



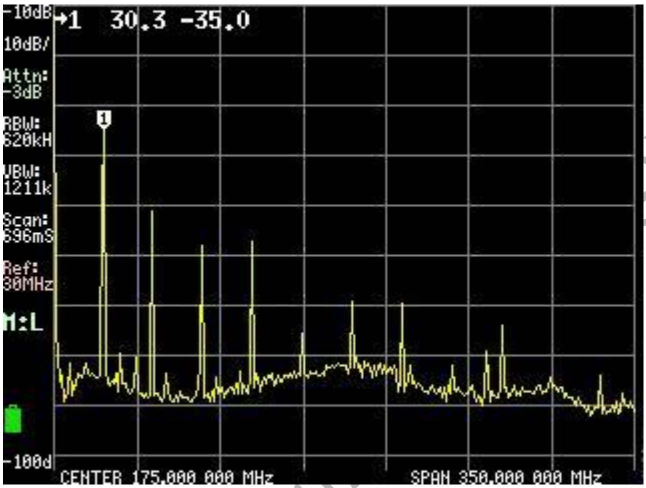
The ground of the audio output circuit can be connected to a pad with a green circle or any other GND PCB edge pin.
The output level is up to 1.5Vpp

The settings of the attenuator

Settings and usage of internal attenuation

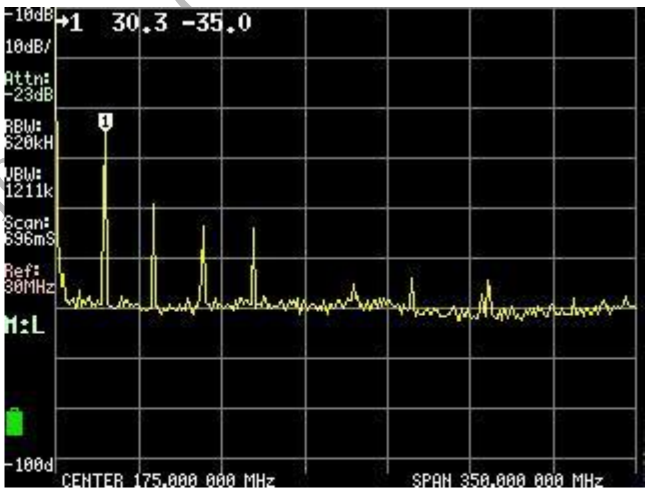
In order to protect TinySA from damage from strong signals or to check for possible overload of

TinySA, it is advisable to always make sure that you have the correct attenuation. Internally, the display data is corrected for the applied attenuation. This is a display with an attenuation of -3dB



The fundamental frequency is 30.3MHz and the intensity is -35dBm

When attenuation is increased, the signal and all its harmonics remain at the same level, but the noise floor rises



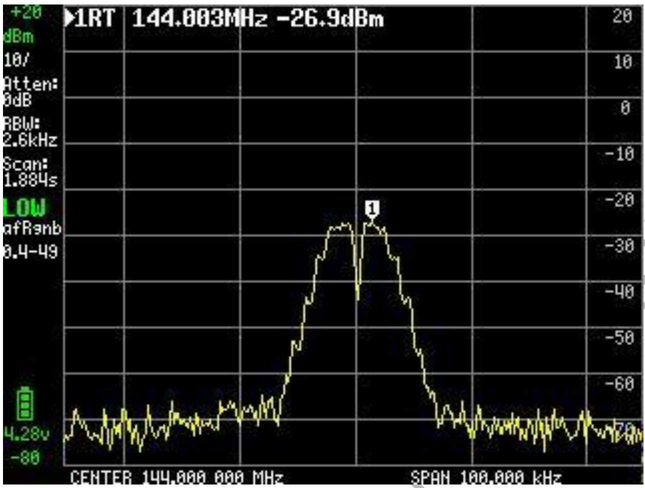
As shown in the figure above, if harmonics remain at the same level as the attenuation increases, it can be determined that these harmonics are not generated internally, but are present in the input signal. When the harmonics decrease in intensity as they increase the attenuation, you have overloaded the TinySA and the harmonics (partially) are generated internally

FM deviation measurement

Using the 2kHz tone, a sag can be seen with these biases: 2.4, 5.52 and 8.66 times the 2kHz harmonics.

Using a 2M transmitter, a 2kHz tone and a deviation of 5kHz you get the sharp dip at the carrier frequency

附件四



Using a deviation of 11kHz you get the next bessel zero