TinySA Ultra Spectrum Analyzer Comparison

Whitham D. Reeve

1. Introduction

In this article I compare some measurements made by the ZS405 TinySA Ultra to the same measurements by the Rohde & Schwarz FPL1003 spectrum analyzer (figure 1). This is not a comprehensive or critical review of either analyzer – it is a quick look at rather simple measurements by relatively low-cost and high-cost spectrum analyzers in order to learn more about their RF measurement capabilities. I assume readers are already familiar with how modern spectrum analyzers work.

The TinySA Ultra is a swept frequency spectrum analyzer. I briefly described its trace detectors and video bandwidth filters in a previous article {Reeve25}. The present article is an extension of that work. The R&S FPL1003 also is a swept frequency analyzer but it switches to an FFT sweep mode and uses FFT filters when the resolution bandwidth is set to 50 kHz or lower; more information about this analyzer is available at {R&S-FPL}.

Figure 1.a ~ TinySA Ultra at approximately 1/5 scale. The touchscreen display size is 4 inch diagonal with 480 x 320 pixels. The only controls are a power on/off slide switch and a *jog* control. Image source: TinySA.org

Figure 1.b ~ FPL1003 at approximately 1/5 scale. The touchscreen display is 10.1 inch diagonal with 1280 x 800 pixels. All buttons and knob controls have touchscreen equivalents and the instrument also may be controlled through its web browser interface. Image source: Rohde & Schwarz

The measurements described here include Displayed Average Noise Level (DANL), unmodulated (CW) and modulated signals from a signal generator, and live FM broadcast band signals. The highest frequency of the FPL1003 is 3 GHz whereas the TinySA Ultra is claimed to be usable to 6 GHz in Ultra mode. My measurements are in the frequency range 1 to 800 MHz, corresponding to the TinySA Ultra's *non-Ultra* mode frequency range, and 1 and 2 GHz with the TinySA Ultra in *Ultra* mode. The FPL1003 covers the entire frequency range in a single spectrum analyzer mode (this analyzer has several other modes).

The TinySA Ultra documentation is not comparable to the FPL1003. The only formal documentation for the TinySA Ultra (and other similar models) is the online TinySA Wiki, and it consists of a page of specifications and several pages of menu definitions and other information; see References. An experienced user has produced a 35 page description. I had to frequently search the TinySA Groups.io user support forum for more information while preparing this and the previous article. For comparison, the FPL user manual is 1156 pages and each option adds 200-300 hundred pages.

2. General Setups

Self-test and internal calibration: The TinySA Ultra has manual self-test and calibration functions; both were run prior to the measurements. The FPL1003 also has internal self-test and calibration functions but these are automatically run each time the analyzer is powered on. It also has a *Self-Alignment* function that is manually run if the ambient temperature has changed or the firmware has been updated, and it was run prior to the measurements. The lab temperature was stable at 20 °C throughout the measurements, and no attempt was made to determine if the analyzers provided different results at different temperatures. Both analyzers can use correction tables for interconnection cables and other devices to improve accuracy but these were not used.

Analyzer power & setup: The TinySA Ultra has an internal battery but I connected it through a USB port on a lab PC so the battery would not run down. I noted no difference in the analyzer noise floor with and without the external power supply. All measurement setups were through the TinySA Ultra touchscreen (a stylus is essential); the TinySA-App software was not used to control the instrument. Screenshots were taken with the TinyRemote screenshot tool. The FPL1003 was powered from a lab ac receptacle and controlled through its LAN connection with a web browser (FireFox) running on the same PC. The spectrum plots were taken by the FPL1003's built-in screenshot utility, which automatically recolors them for printing.

Start mode: The TinySA Ultra starts with its default span from 0 to 800 MHz and the FPL1003 starts with its default span from 5 kHz to 3 GHz. To measure frequencies above 800 MHz, it is necessary to manually set the TinySA Ultra to the Ultra mode. There is no indication that it is in the Ultra mode except in the menus (a checkbox). According to the TinySA Wiki: *Enabling Ultra mode has no negative impact on measurements below the Ultra Start frequency*. Almost all measurements below 800 MHz were made prior to switching to the Ultra mode.

Analyzer RF input power: The first step in using any spectrum analyzer is to ensure its RF input will not be overloaded and possibly damaged. This is especially important with the TinySA Ultra – the TinySA Groups.io forum has regular inquiries about testing and repairing damaged front-ends. The TinySA Ultra has the following specifications: 1) Absolute maximum input level of +6 dBm (4 mW) with the internal attenuator set to 0 dB; 2) Absolute maximum short term peak input power of +20 dBm (100 mW) with the internal attenuator set to 30 dB; 3) Suggested maximum input power of 0 dBm (1 mW) with the internal attenuator set to Auto; 4) Recommended input power ≤ –25 dBm (3.2 µW) for *best measurements*. As for the FPL1003, the specified maximum power input is +20 dBm (100 mW) with the internal attenuator set to 0 dB and +30 dBm (1 W) with it set ≥ 10 dB. Both maximums are reduced 7 dB when the FPL's internal preamplifier is enabled. The TinySA Ultra does not provide an on-screen warning if the maximum allowed input power is exceeded but the FPL does.

Sweep points: The TinySA's maximum horizontal trace display resolution is 450 pixels with one sweep point per pixel (it can be set to lower values). When used with PC application software, the sweep points can be set to any practical value but that was not done here. The FPL1003's maximum horizontal trace display resolution is 1000 pixels but the sweep points can be set up to 100 001 on the instrument itself. The FPL User Manual says the highest resolution is provided when the Span/RBW ratio = 1000 (or, RBW = Span/1000). Since the TinySA Ultra has the limiting resolution, both instruments were set to display 450 points with the Sweep Time parameters set to Auto.

3. Comparative Measurements

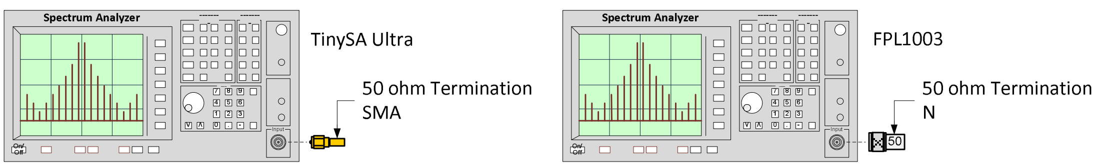
I made three sets of measurements, which are discussed in this section: Measurement Set No. 1 investigates the Displayed Average Noise Level (DANL), which indicates the analyzer sensitivity and is useful in device noise and weak signal investigations; Measurement Set No. 2 explores unmodulated and modulated signals from an RF signal generator. Analyzing these types of signals is useful in signal measurements and radio frequency interference (RFI) investigations; and Measurement Set No. 3 captures live signals in the FM broadcast band to compare how the analyzers handle relatively strong FM modulated signals in a live ambient RF background.

I attempted to make the analyzer setups the same so that equal comparisons could be made. Unavoidable differences, of which there were very few, are discussed in each measurement set. Because the number of ease-of-use and advanced features are very limited in the TinySA Ultra compared to the FPL1003, I did not take advantage of the FPL1003's many intrinsic signal analysis capabilities.

Measurement Set No. 1: Displayed Average Noise Level using a Noise Marker and with the low noise amplifier (LNA) in the TinySA Ultra and the Preamplifier in the FPL1003 Off and On.

Connections: See connection diagram below (figure 1.1). A 50 ohm termination was connected directly to the RF input port of each instrument.

Figure 1.1 ~ Connection diagram for Measurement Set No. 1



Settings: The Noise Marker used during the DANL measurements produces a reading in dBm Hz^{-1} (displayed as *dBm/Hz* on both instruments) after correcting for the Resolution Bandwidth (RBW) filter shape and width and for the trace detector and averaging settings. The lowest RBW filter setting in the TinySA Ultra is 200 Hz whereas it is 1 Hz in the FPL1003. To allow equal comparison, the RBW filter in both analyzers was set to 1 kHz. This higher RBW setting turned out to be very useful because it allowed faster sweep times and significantly sped up the measurements by the TinySA Ultra compared to lower RBW settings. See table 1.1 for additional settings.

Table 1.1 ~ Settings:

Analyzer →	TinySA Ultra	FPL1003	Remarks
Center Frequency	See Table 1.2	See Table 1.2	
Span	1 KHz	1 kHz	
Sweep Points	450	450	
Sweep Time, ≤ 750 MHz	3.2 min	85 ms	TinySA Ultra in non-Ultra mode, Note 3.a.
Sweep Time, > 800 MHz	6.1 min	85 ms	TinySA Ultra in Ultra mode, Note 3.a.
Trace Detector	AVER	Average/100	
Reference Level	–70 dBm	–80 dBm	
Attenuator	0 dB	0 dB	
RBW	1 kHz	1 kHz	
RBW/VBW	100	100	

Measurement results: See table 1.2.

Table 1.2 ~ Measurement results. Appendix I contains reference screenshots for the measurements tabulated here (Note: Only the online version of this article includes Appendix I).

Center Frequency →	1 MHz	10 MHz	100 MHz	500 MHz	750 MHz	1 GHz	2 GHz	Remarks
TinySA Ultra – LNA Off (dBm Hz^{-1})	–149.0	–153.5	–154.8	–152.4	–149.8	–149.8	–151.6	
TinySA Ultra – LNA On (dBm Hz^{-1})	–171.3	–171.5	–171.1	–170.9	–170.0	–167.6	–169.6	
Measured NF – LNA On (dB)	5.7	4.7	4.8	4.9	5.0	7.2	5.8	Note 2.d.& e
FPL1003 – Preamp Off (dBm Hz^{-1})	–149.5	–152.3	–151.8	–151.5	–151.6	–150.0	–152.0	
FPL1003 – Preamp On (dBm Hz^{-1})	–149.5	–166.9	–167.1	–166.7	–167.0	–166.3	–166.5	Note 3.b.
Calculated NF – Preamp On (dB)	24.5	7.1	6.9	7.3	7.0	7.7	7.5	Note 1.a.
|Δ| DANL TinySA Ultra and FPL1003 – LNA/Preamp Off (dB)	0.5	1.2	3.0	0.9	1.8	0.2	0.4	
|Δ| DANL TinySA Ultra and FPL1003 – LNA/Preamp On (dB)	21.8	4.6	4.0	4.2	3.0	1.3	3.1	Note 3.b.& e.

Measurement Set No.1 Notes:

1. General –
   a. $NF_{SA} = DANL + 174\ dBm\ Hz^{-1},\ or\ DANL - NF_{SA} = -174\ dBm\ Hz^{-1}$ (DANL normalized to 1 Hz; equation applies only if the Noise Marker used to measure DANL incorporates averaging and filter bandwidth and shape corrections).
2. TinySA Ultra –
   a. Noise Marker reading was inconsistent for different RBW and span settings but all within ±2 dB (absolute power accuracy specification is ±2 dB).
   b. Observed repeatability generally was ±0.5 dB.
   c. For reasons unknown, could not measure the noise floor at 800 MHz in non-Ultra mode so the frequency was reduced to 750 MHz in that mode. Measurements at 1 and 2 GHz used Ultra mode.
   d. The internal LNA noise figure measurement function measures the noise figure twice and compares them to determine the error. The reported error generally was –0.1/+0.2 dB.
   e. Measured noise figure and DANL combined do not give –174 dBm Hz^{-1} but generally are still within the specified absolute power measurement accuracy. See also Notes 1.a. and 2.a.
   f. Ultra mode unlock key is 4321.
3. FPL1003 –
   a. The FPL switches to FFT sweep mode when the RBW is set to 50 kHz and lower.
   b. The FPL1003 preamplifier apparently is switched out below 3 MHz (the datasheet does not show a specification for the preamplifier below 3 MHz).
   c. The FPL accuracy is given as uncertainty and is < 0.3 dB between 3 MHz and 3 GHz.

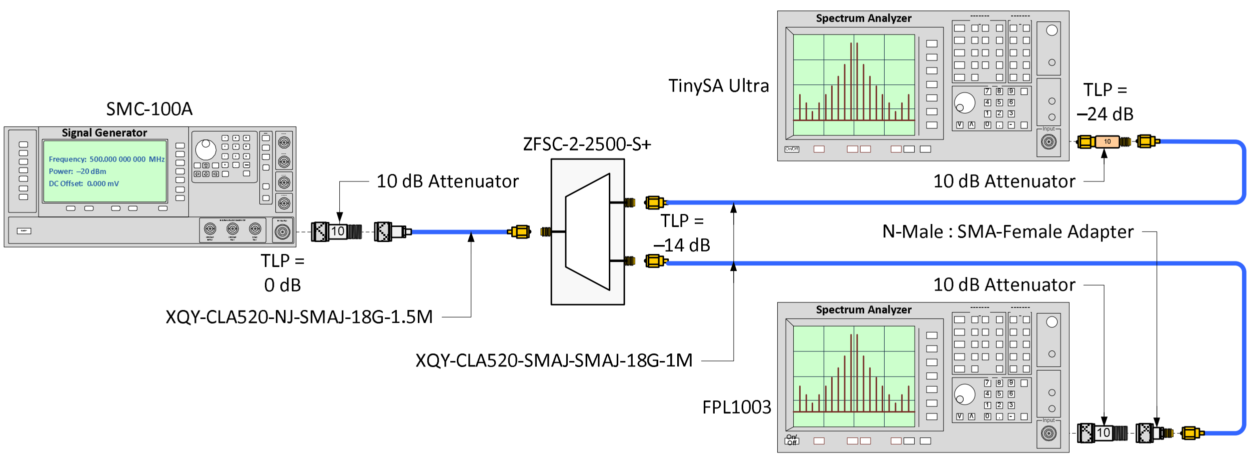
d. Observed repeatability generally was better than ±0.1 dB.
e. The higher noise figure of the FPL1003 preamplifier contributed to its higher DANL compared to the TinySA Ultra LNA.

Measurement Set No. 2: Unmodulated and modulated signals

Settings: The frequency for the measurements in this set was either 500 MHz or 1 GHz with various signal levels and analyzer resolution bandwidths. The TinySA Ultra was set to Ultra mode. Neither the TinySA Ultra LNA nor the FPL1003 preamplifier was used. The specific settings and results for each measurement are listed in tables 2.1 through 2.10 below.

Connections: See connection diagram below (figure 2.1). To allow simultaneous measurements, the signal generator was connected through a 10 dB fixed attenuator on the generator output to a Mini-Circuits 2-way power splitter and from the splitter to a 10 dB fixed attenuator connected at the input of each analyzer. The attenuators were installed to provide analyzer input *protection insurance* as well as to improve the impedance matching. Precision test cables were used for all connections. The TinySA Ultra uses an SMA connector and the FPL uses an N connector.

Figure 2.1 ~ Connection diagram for Measurement Set No. 2



RF signal generator: A calibrated R&S SMC-100A RF signal generator was used to produce unmodulated carrier wave (CW) and amplitude modulated (AM) signals. The signal generator was controlled through its web browser interface.

Modulation: One measurement was made at 500 MHz using AM. The modulation frequency was arbitrarily set to 100 kHz with an index of 90%. The calculated sideband level relative to the carrier for AM with this setting is –7 dB (for example, see: https://www.rfwireless-world.com/calculators/amplitude-modulation-formula-calculator).

Markers: For all but the modulated carrier measurements, a *Normal* Marker was placed at the signal peak and another on the noise floor 100 MHz away. Only the Peak Marker is compared but both marker levels are listed in the tables and displayed in the plots. For the AM measurements, a Marker was placed on the carrier peak and on the upper sideband.

Signal levels: The input signal levels given in the measurement result tables are the signal generator output level setting less 20 dB (the losses of two 10 dB attenuators). For example, to achieve a nominal –60 dBm analyzer input signal level, the signal generator was set to –40 dBm. This is not the actual level into the analyzer because of the offset due to splitter and cable losses. The estimated offsets are 4.0 dB at 500 MHz and 4.2 dB at 1 GHz. Note that the Reference Level Offset functions in the analyzers were not used for these measurements.

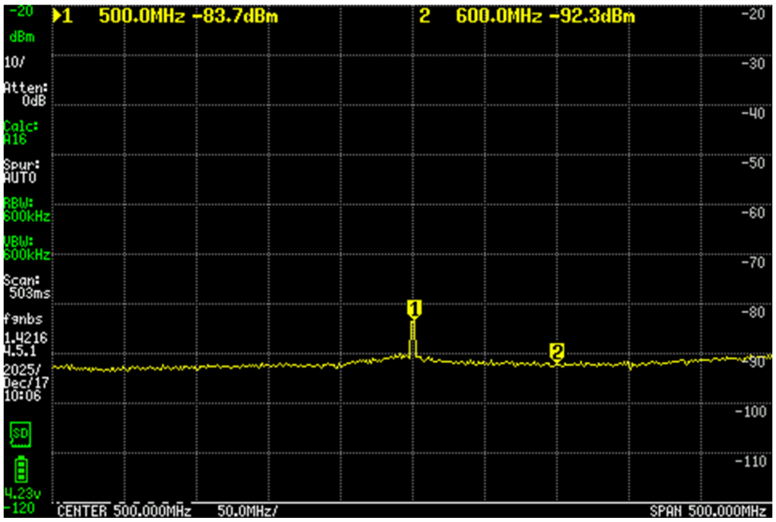
Spurious signals: The TinySA Ultra is known to emit spurious signals (local oscillator leakage) from its RF input port when in Ultra mode but only above 800 MHz. Although the splitter provides nearly 20 dB isolation between ports and the fixed attenuators provide another 20 dB reduction, spurious signals from the TinySA Ultra were occasionally seen in the FPL1003 spectra but none were seen in the documented measurements. On the other hand, self-generated spurious signals were seen in the measured TinySA Ultra spectra.

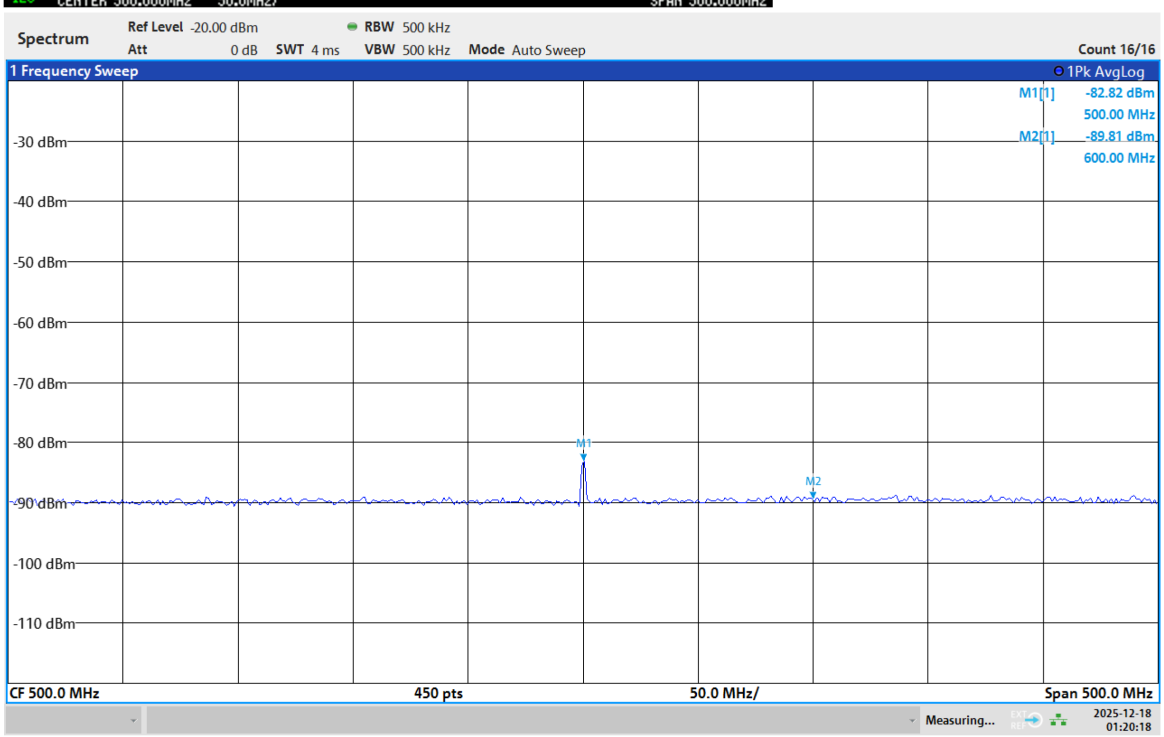
Resolution bandwidth filters: The widest RBW setting in the TinySA Ultra is 600 kHz; it does not have a 500 kHz setting. The FPL1003 does not have a 600 kHz RBW filter so its nearest setting of 500 kHz was used for two of the measurements. The different settings do not affect the signal measurements but have a small effect (0.8 dB) on the noise floor but not the carrier measurements.

Measurement results: See table 2.1 through 2.10.

Table 2.1 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
500	500	–80	500	600	600/500	1.0	Average 16
Meas. 2.1	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	The difference in Peak marker readings is 0.9 dB.		
TinySA Ultra	–20 dBm	503 ms	–83.7 dBm	–92.3 dBm			
FPL1003	–20 dBm	4 ms	–82.8 dBm	–89.8 dBm			

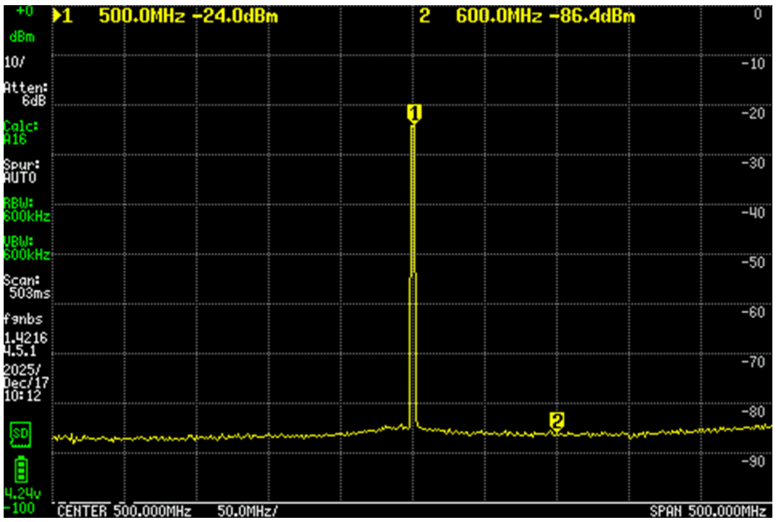


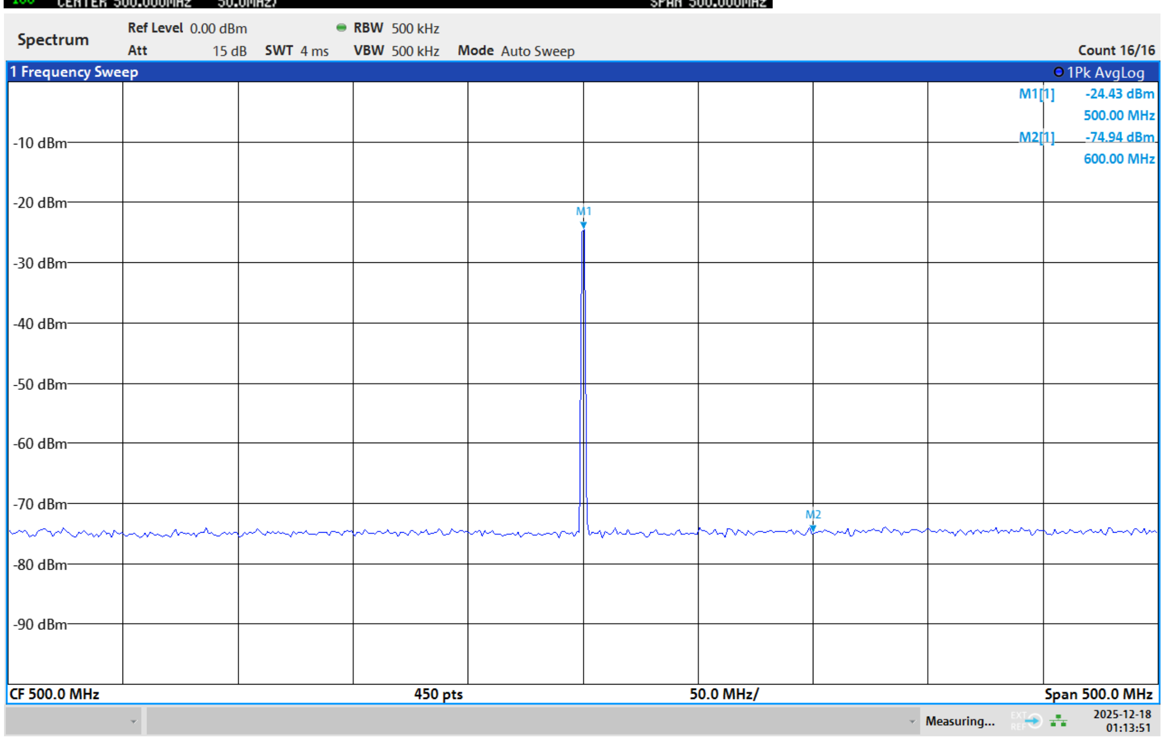


01:20:19 AM 12/18/2025

Table 2.2 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
500	500	–20	500	600	600/500	1.0	Average 16
Meas. 2.2	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**			
TinySA Ultra	0.0 dBm	503 ms	–24.0 dBm	–86.4 dBm	The difference in Peak marker readings is 0.4 dB.		
FPL1003	0.0 dBm	4 ms	–24.4 dBm	–74.9 dBm			

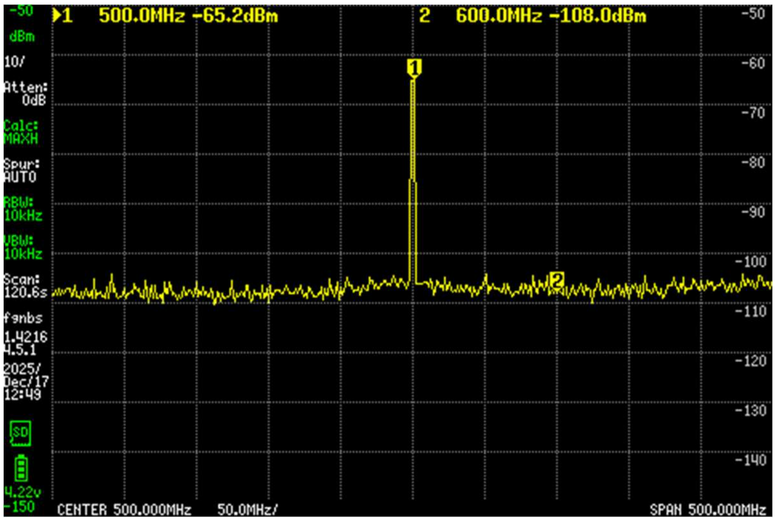


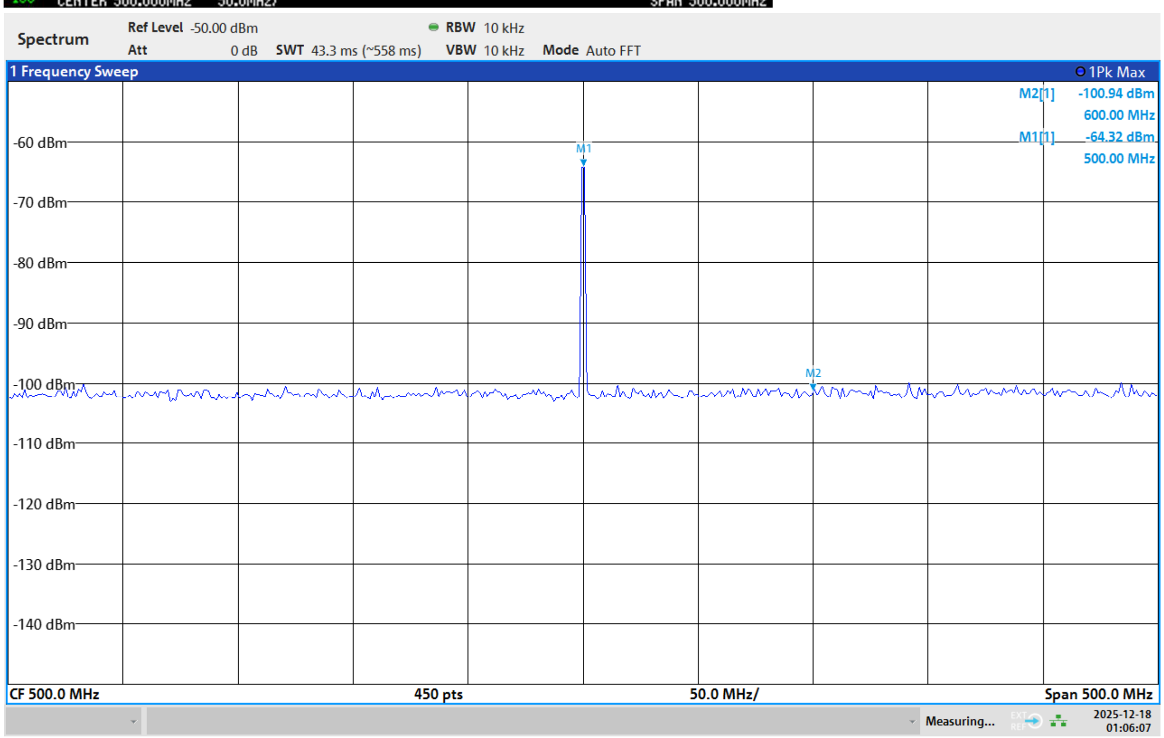


01:13:52 AM 12/18/2025

Table 2.3 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
500	500	–60	500	600	10	1.0	Max Hold
Meas. 2.3	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	The difference in Peak marker readings is 0.9 dB.		
TinySA Ultra	–50.0 dBm	121 s	–65.2 dBm	–108.0 dBm			
FPL1003	–50.0 dBm	558 ms	–64.3 dBm	–100.9 dBm			

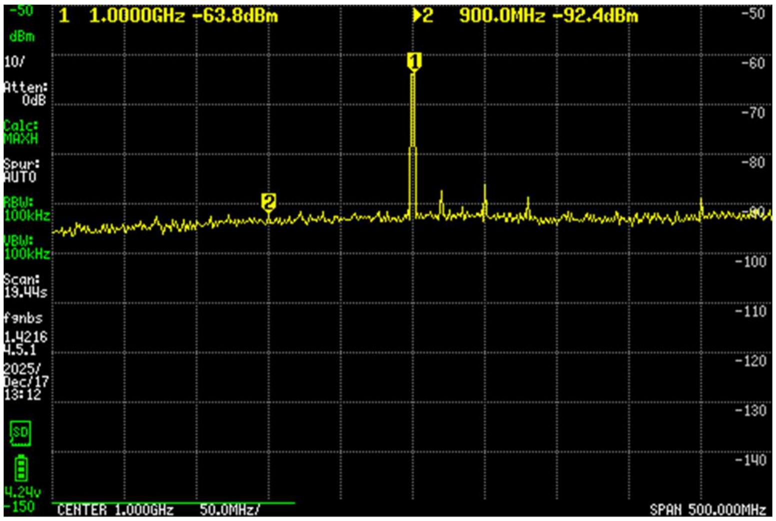


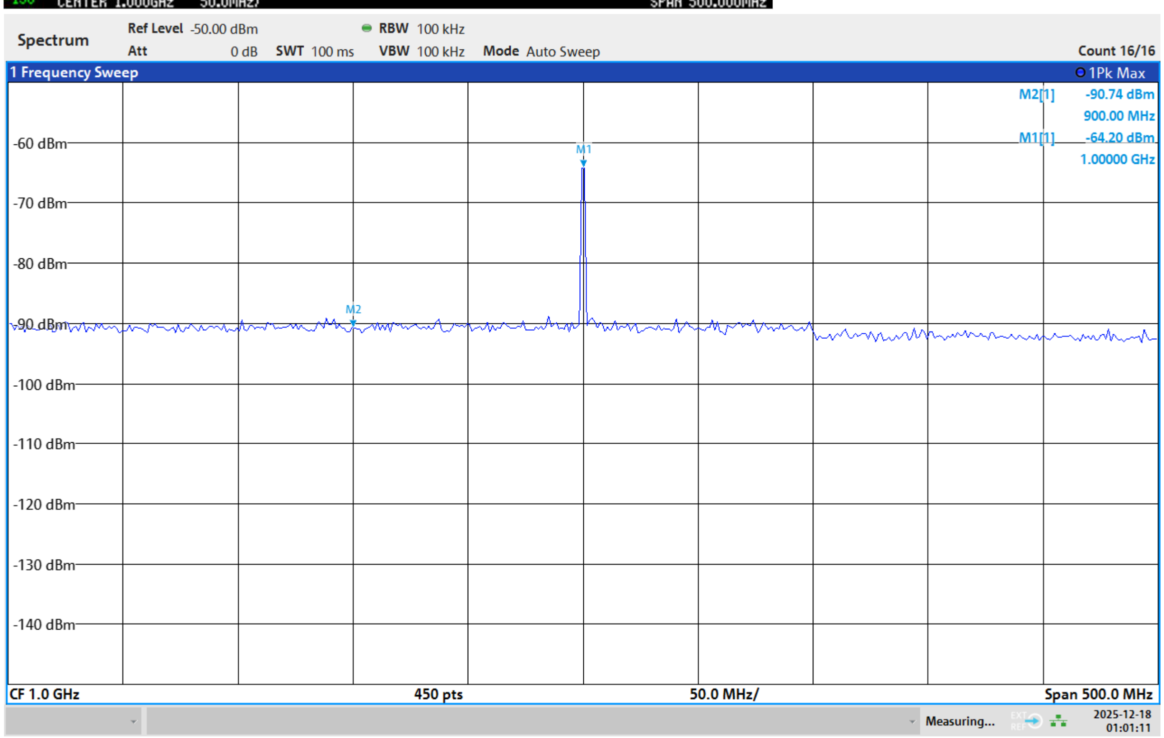


01:06:07 AM 12/18/2025

Table 2.4 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	500	–60	1000	900	100	1.0	Max Hold
Meas. 2.4	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	Spurious signals are visible in the TinySA Ultra measurements. The difference in Peak marker readings is 0.4 dB.		
TinySA Ultra	–50.0 dBm	13 s	–63.8 dBm	–92.4 dBm			
FPL1003	–50.0 dBm	100 ms	–64.2 dBm	–90.7 dBm			

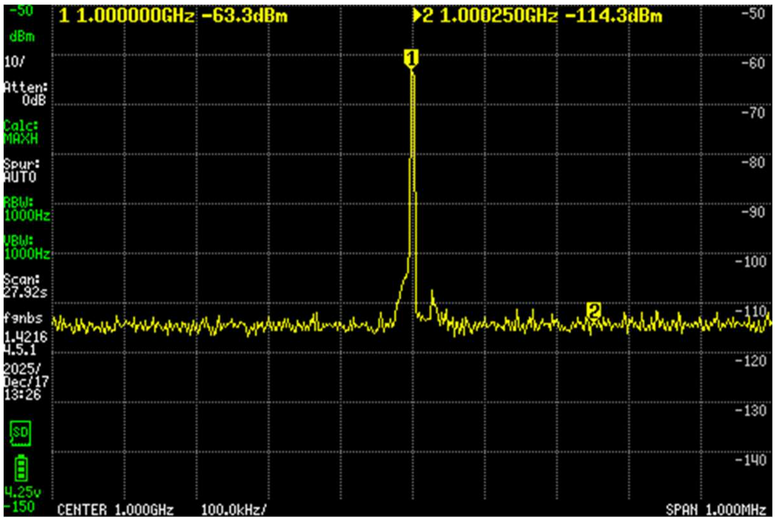


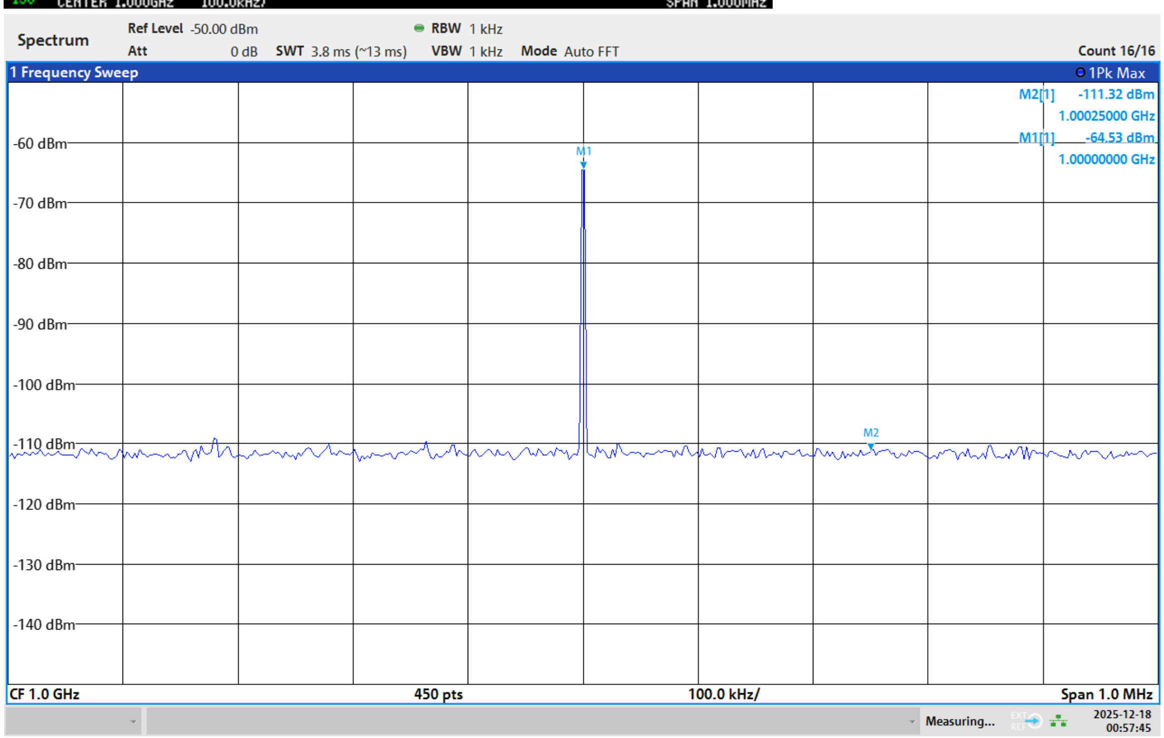


01:01:12 AM 12/18/2025

Table 2.5 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	1	–60	1000	1000.250	1	1.0	Max Hold
Meas. 2.5	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	Low level spurious signals are visible in the TinySA Ultra measurements. The difference in Peak marker readings is 1.2 dB.		
TinySA Ultra	–50.0 dBm	28 s	–63.3 dBm	–114.3 dBm			
FPL1003	–50.0 dBm	13 ms	–64.5 dBm	–111.3 dBm			

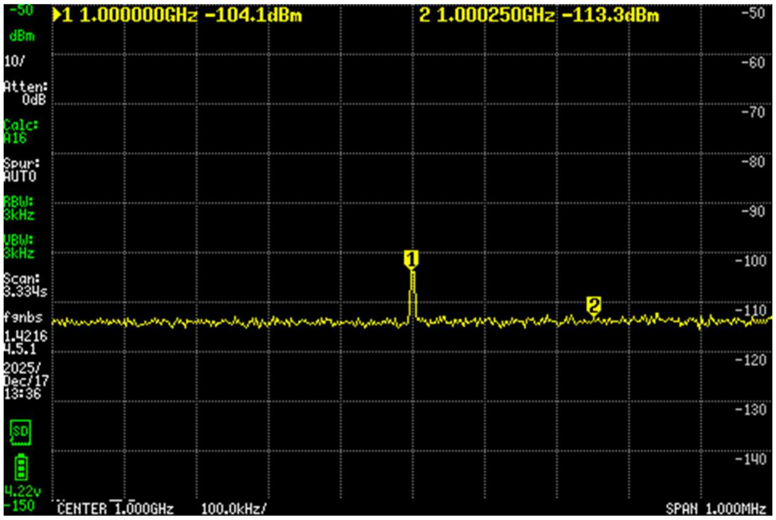


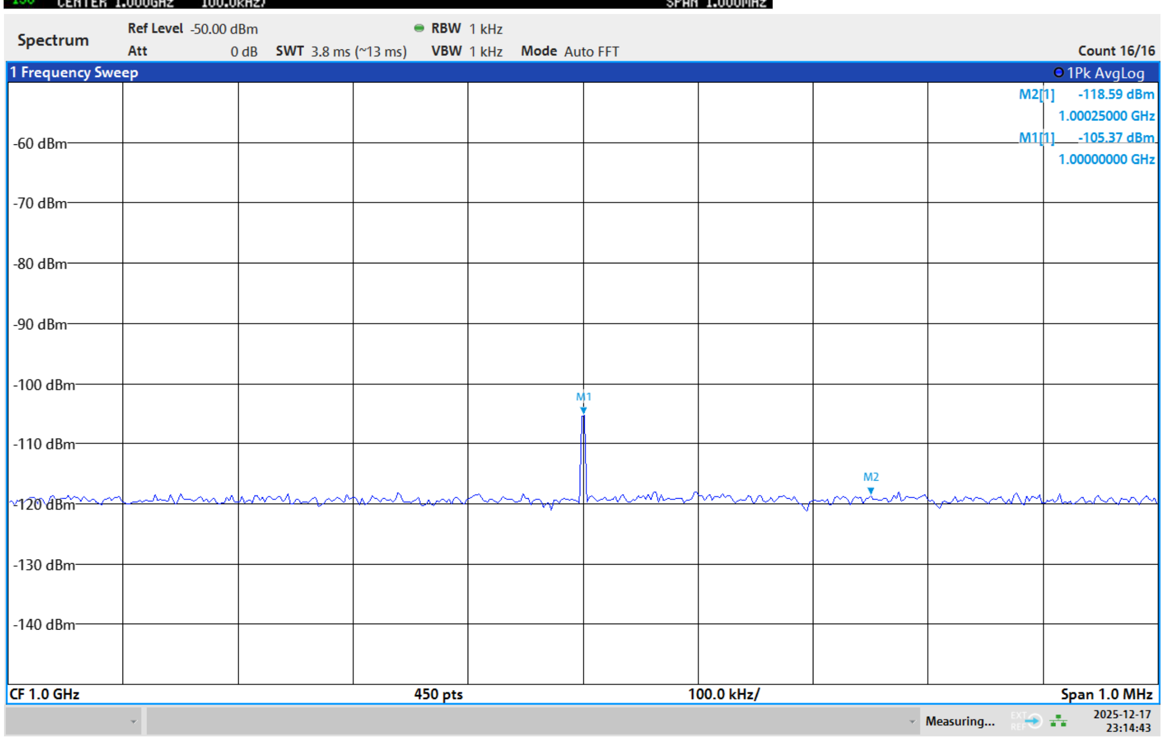


12:57:45 AM 12/18/2025

Table 2.6 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	1	–100	1000	1000.250	3	1.0	Average 16
Meas. 2.6	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	The difference in Peak marker readings is 1.3 dB.		
TinySA Ultra	–50.0 dBm	3 s	–104.1 dBm	–113.3 dBm			
FPL1003	–50.0 dBm	13 ms	–105.4 dBm	–118.6 dBm			

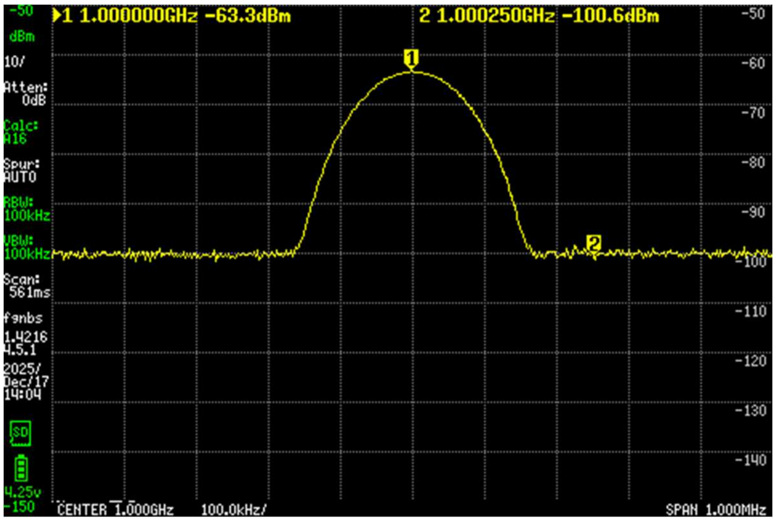


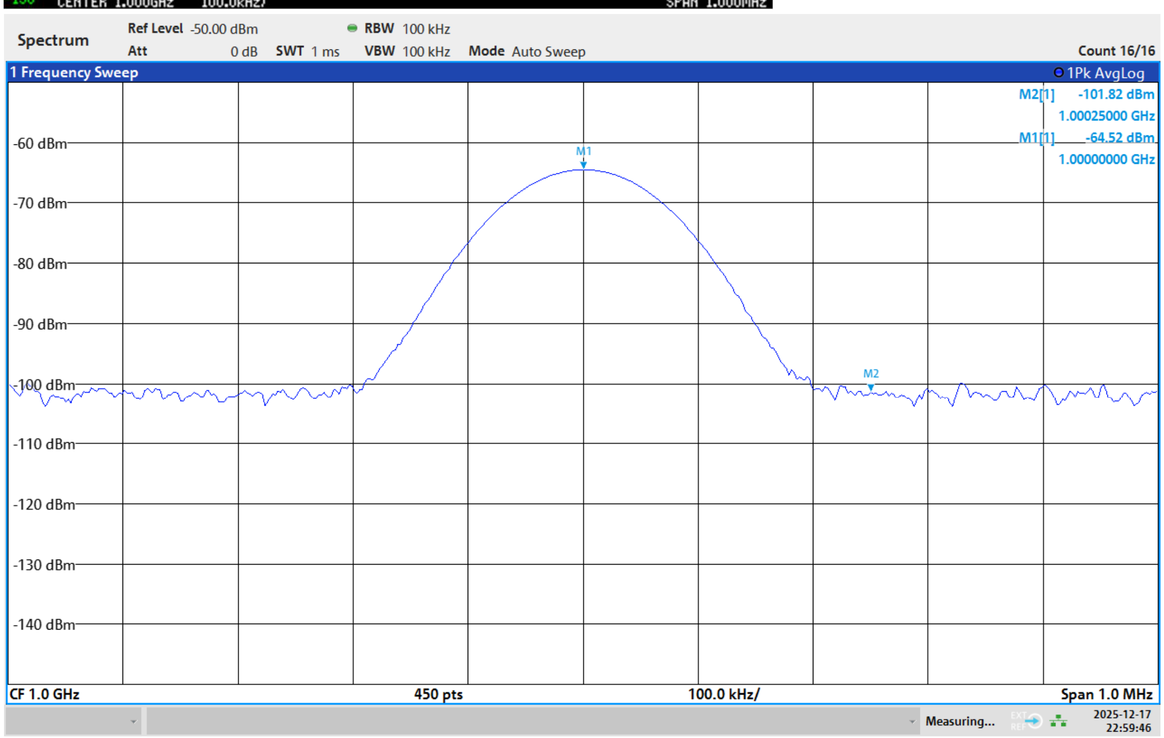


11:14:44 PM 12/17/2025

Table 2.7 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	1	–60	1000	1000.250	100	1.0	Average 16
Meas. 2.7	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	The difference in Peak marker readings is 1.2 dB.		
TinySA Ultra	–50.0 dBm	561 ms	–63.3 dBm	–100.6 dBm			
FPL1003	–50.0 dBm	1 ms	–64.5 dBm	–101.8 dBm			

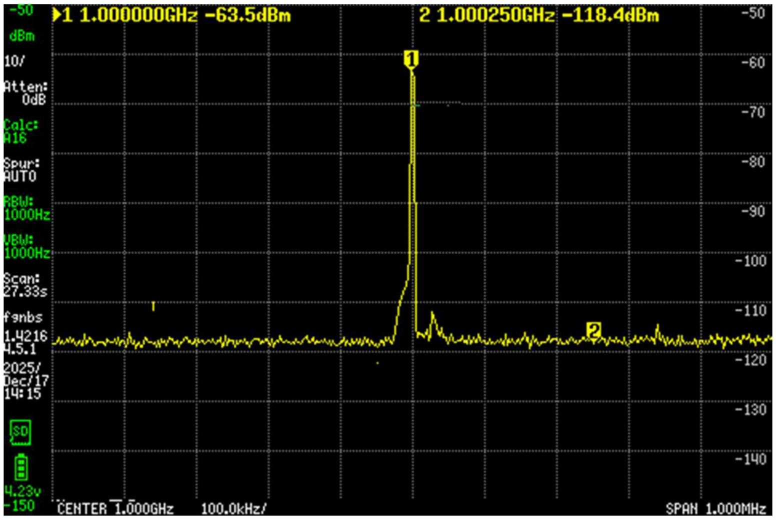


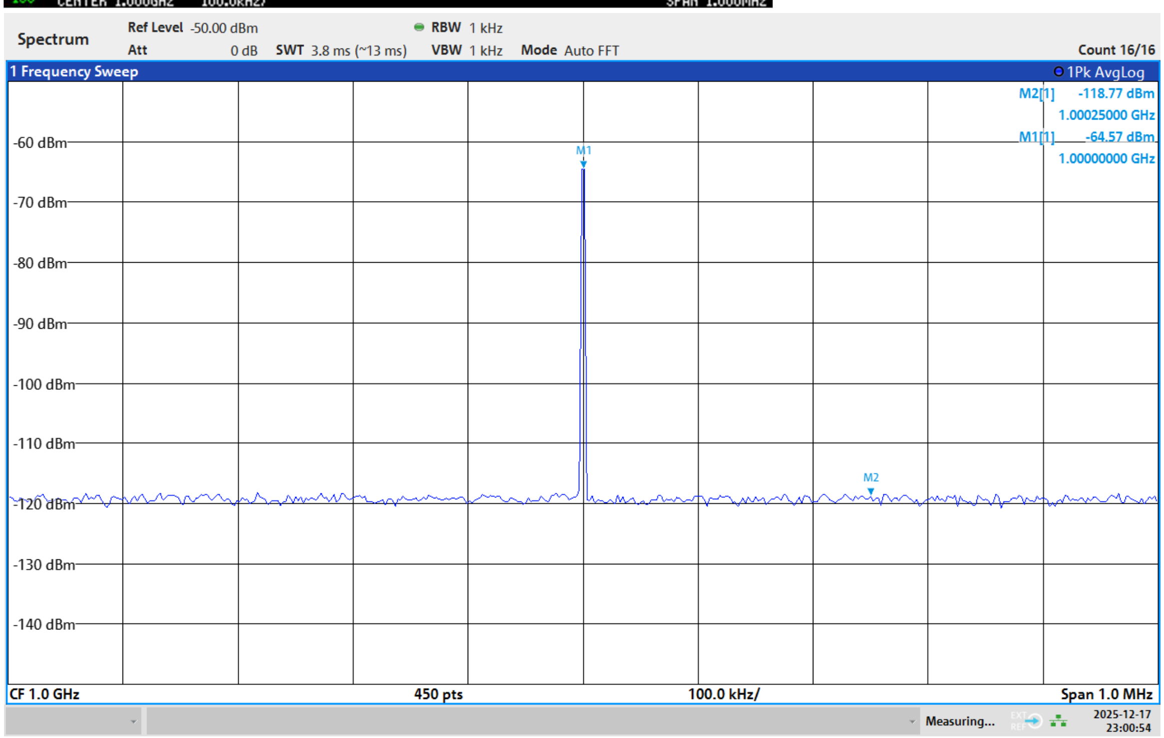


10:59:46 PM 12/17/2025

Table 2.8 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	1	–60	1000	1000.250	1	1.0	Average 16
Meas. 2.8	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	Spurious signals are visible in the TinySA Ultra measurements. The difference in Peak marker readings is 1.1 dB.		
TinySA Ultra	–50.0 dBm	27 s	–63.5 dBm	–118.4 dBm			
FPL1003	–50.0 dBm	13 ms	–64.6 dBm	–118.8 dBm			

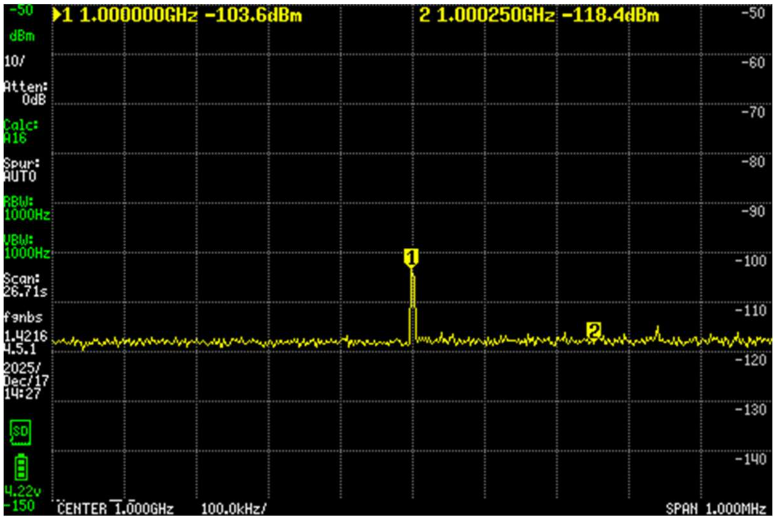


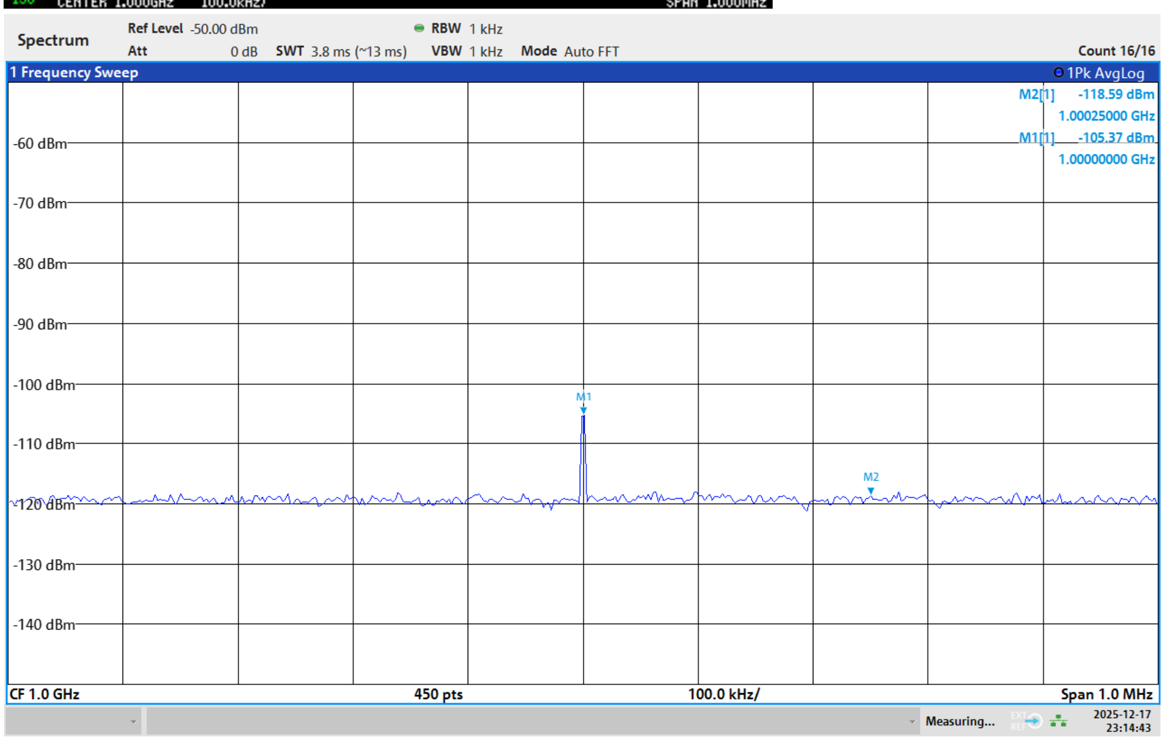


11:00:54 PM 12/17/2025

Table 2.9 ~ Unmodulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
1000	1	–100	1000	1000.250	1	1.0	Average 16
Meas. 2.9	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	Low level spurious signals are visible in the TinySA Ultra measurements. The difference in Peak marker readings is 1.8 dB.		
TinySA Ultra	–50.0 dBm	29 s	–103.6 dBm	–118.4 dBm			
FPL1003	–50.0 dBm	13 ms	–105.4 dBm	–118.6 dBm			

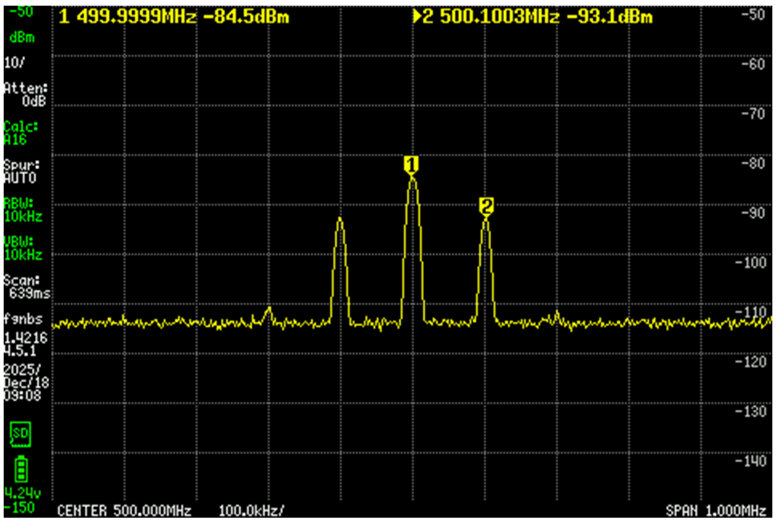


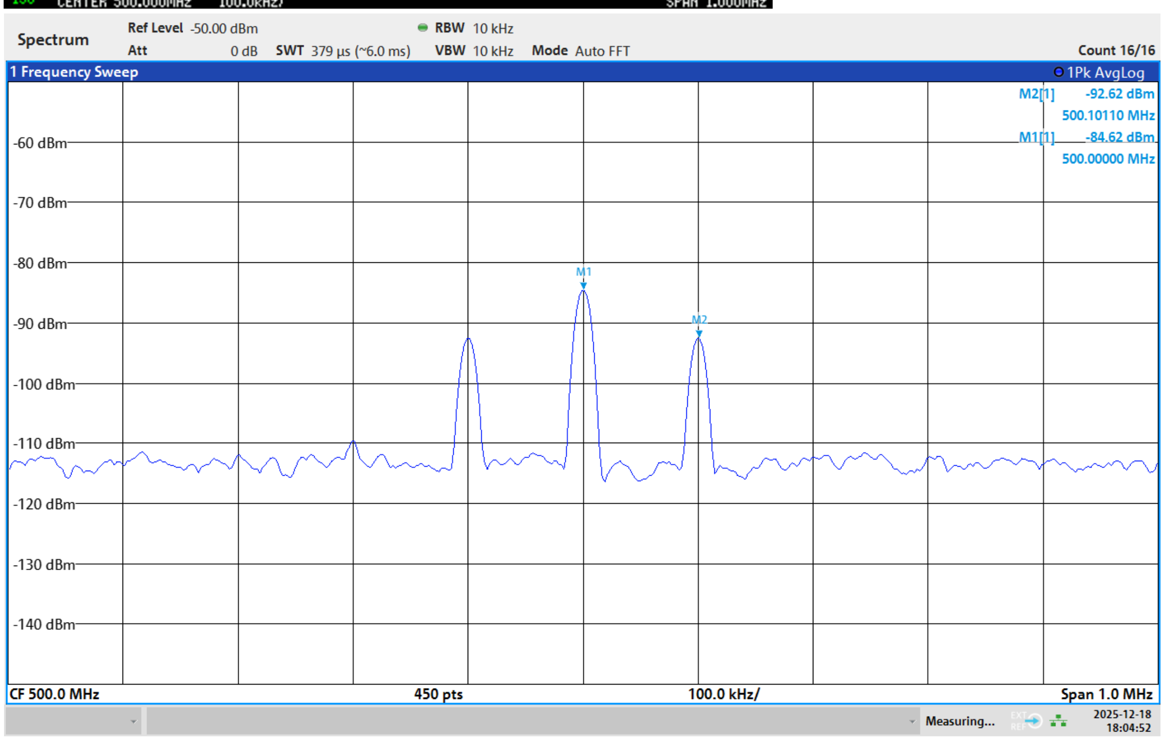


11:14:44 PM 12/17/2025

Table 2.10 ~ Amplitude modulated carrier

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace	Mod.
500	1	–80	500	500.100	1	1.0	Average 16	AM, 100 kHz, 90%
Meas. 2.10	**Ref Level**	**Sweep time**	**CXR Mrkr**	**SB Mrkr**	Note: The calculated sideband level relative to the carrier for AM with modulation index of 90% is –7 dB. The difference in Peak marker readings is 0.1 dB and sideband readings is 0.5 dB.			
TinySA Ultra	–50 dBm	633 ms	–84.5 dBm	–93.1 dBm				
FPL1003	–50 dBm	6 ms	–84.6 dBm	–92.6 dBm				





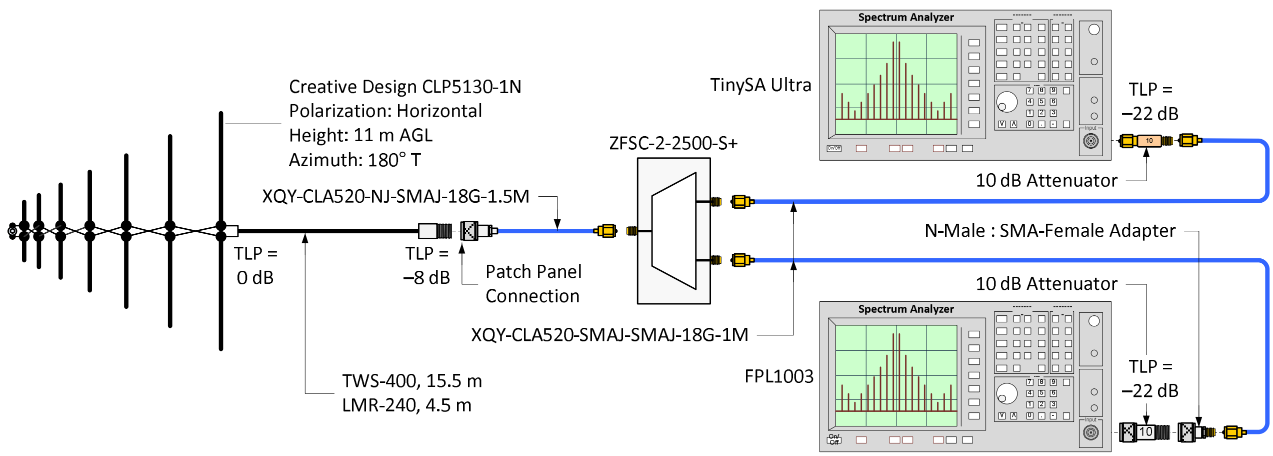
06:04:53 PM 12/18/2025

Measurement Set No. 3: Live FM broadcast band signals

Settings: These measurements are similar to analyzer measurements described in {Reeve20a} and {Reeve20b} except those articles focused on filters. For the present measurements, the TinySA Ultra already was in the Ultra mode and it was left there even though not necessary. Two measurements were made, and the specific settings and results are listed in tables 3.1 and 3.2 below.

Connections: See connection diagram below (figure 3.1). The antenna was connected to the two analyzers through the same splitter and attenuators used in Measurement Set No. 2.

Figure 3.1 ~ Connection diagram for Measurement Set No. 3. The horizontally polarized log periodic dipole array (LPDA) antenna is connected through a 4-Way splitter (not shown) to a Patch Panel. The antenna signals are attenuated by the feedline and splitter, and the transmission level point (TLP) at the Patch Panel is approximately –8 dB with respect to the antenna. The measurement splitter, associated cables and input attenuators introduce approximately additional 14 dB loss, reducing the TLP at the analyzers to about –22 dB.



Frequencies: Initial exploratory measurements were from 88 to 108 MHz, the frequency range of the FM band in the USA. Additional measurements focused on the 92.1 MHz station KBBO, which is about 18 miles east-northeast of the Anchorage Radio Observatory where these measurements were made. This station was arbitrarily chosen and was not in the main beam of the antenna.

Signal levels: The initial measurements indicated additional external attenuation was not needed to avoid analyzer front-end overload, but I left the 10 dB attenuators on the analyzer inputs anyway. The antenna does not have a low noise amplifier and neither the TinySA Ultra LNA nor the FPL1003 preamplifier was used.

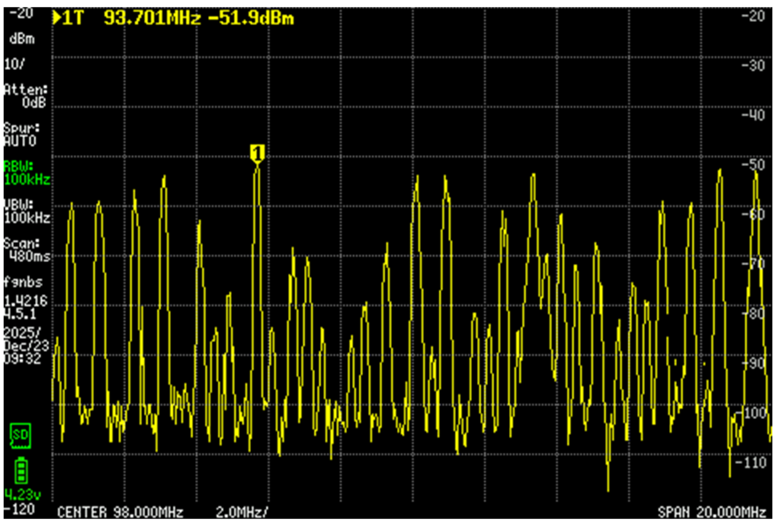
Resolution bandwidth filters: Measurements of the entire FM band were made with the RBW set to 100 kHz and of the individual station with it set to 3 kHz.

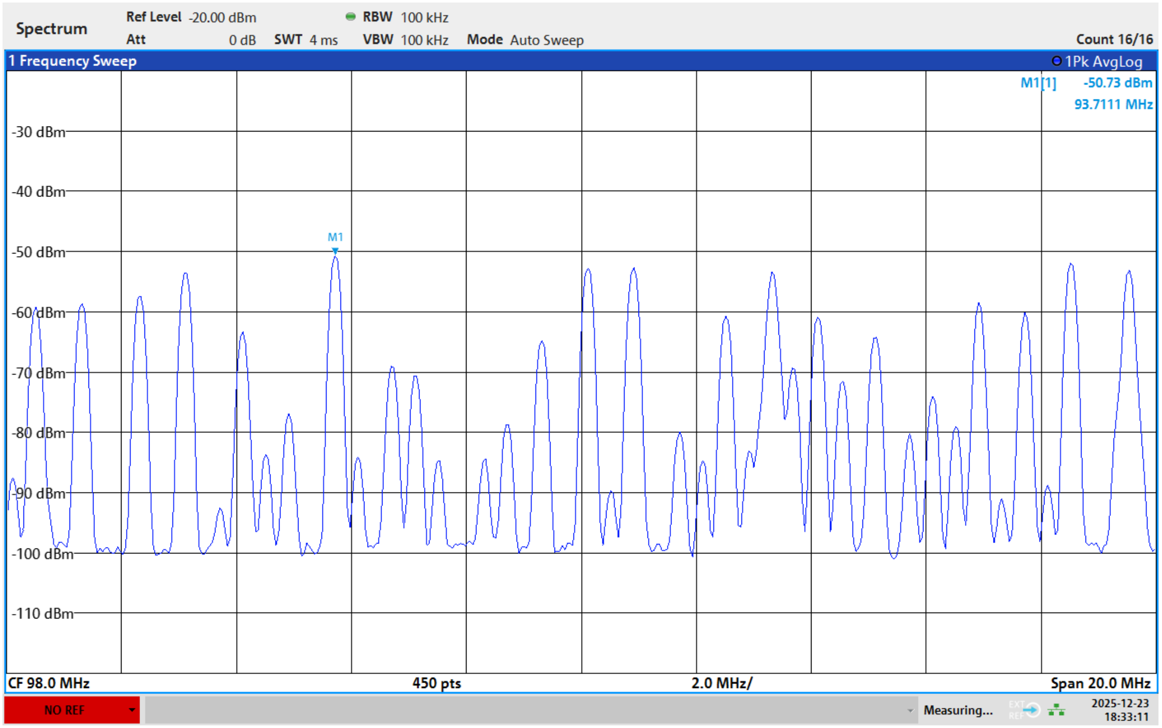
Measurement results: See table 3.1 and 3.2. Note: The analyzer was temporarily disconnected from the 10 MHz Reference Frequency source and moved from the lab, which produced a warning in the lower-left corner of the FPL1003 plots. Two traces were used in both analyzers, one set to Average and the other to Max Hold. After a few minutes, the Max hold trace shows a relatively smooth modulation envelope over that time interval. The envelope changes with program content (music, voice, and so on).

I did not specifically measure FM deviation but an estimate of it can be derived from the plots. FM broadcast channels are 200 kHz wide, and a frequency deviation of ±75kHz is defined as 100% modulation. Federal Communications Commission regulations require that at ±120 kHz from the center frequency, the transmitted signal must be –25 dBc or lower [47 CFR 73.317(b)]. Both plots in Measurement 3.2 appear to show a signal meeting this requirement. Markers could have been used for this purpose.

Table 3.1 ~ 20 MHz frequency span

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
98	20	Live	93.7	N/A	100	1.0	Average 16
Meas. 3.1	**Ref Level**	**Sweep time**	**Peak Mrkr**	**Floor Mrkr**	The difference in Peak marker readings is 1.2 dB. but signal levels were variable and not measured at exactly the same time.		
TinySA Ultra	–20 dBm	480 ms	–51.9 dBm	N/A			
FPL1003	–20 dBm	4 ms	–50.7 dBm	N/A			

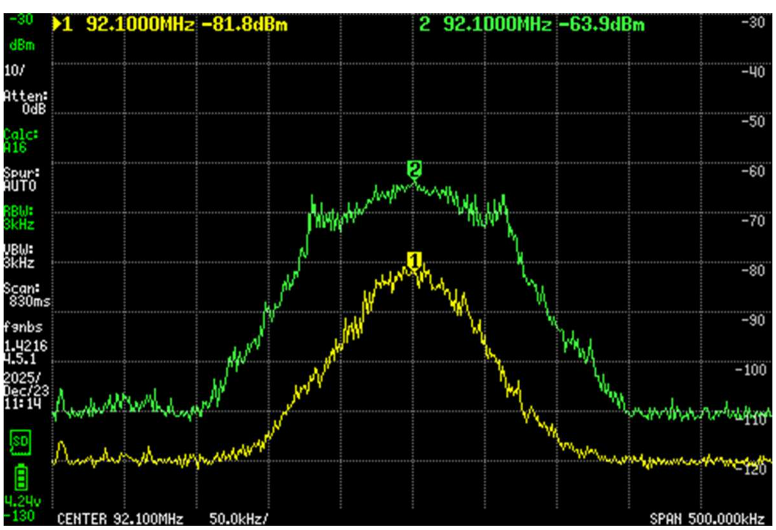


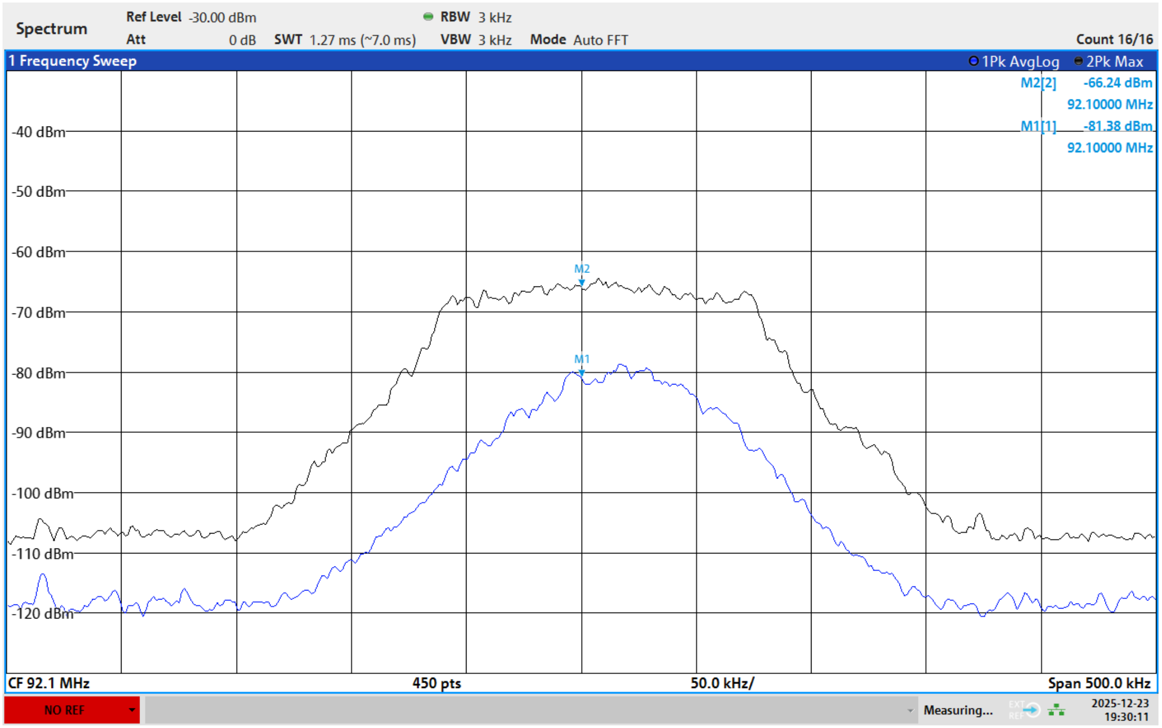


06:33:11 PM 12/23/2025

Table 3.2 ~ 500 kHz frequency span

CF (MHz)	Span (MHz)	Input (dBm)	Mrkr 1 (MHz)	Mrkr 2 (MHz)	RBW (kHz)	RBW/VBW	Trace
92.1	0.500	Live	92.1	92.1	3	1.0	Average 16 & Max Hold
Meas. 3.2	**Ref Level**	**Sweep time**	**Peak Mrkr1**	**Peak Mrkr2**	The difference in Peak marker 1 readings is 0.4 dB and Peak marker 2 is 2.3 dB. Note horns in spectra at ±60 kHz from center frequency in the Max Hold traces.		
TinySA Ultra	–30 dBm	830 ms	–81.0 dBm	–63.9 dBm			
FPL1003	–30 dBm	7 ms	–81.4 dBm	–66.2 dBm			





07:30:11 PM 12/23/2025

---

4. Summary

The TinySA Ultra RF power measurements at the frequencies and under the conditions described above are nearly the same as the FPL1003 measurements. The differences appear to be mostly within the accuracy bounds of the two analyzers. Repeatability of the TinySA Ultra was not as good as the FPL1003 but still quite good considering the relative cost of the smaller analyzer.

The results in Measurement Set No. 1 show the improvements that a low noise preamplifier has on the DANL. The TinySA Ultra DANL measurements with the LNA turned On were consistently optimistic but apparently within the specified accuracy. Noise marker measurements of the DANL should yield very close to the same value regardless of RBW and reasonable span settings, but the TinySA Ultra DANLs varied up to a couple dB. On the other hand, the FPL1003 DANL measurements with a Noise Marker were consistent across all settings tried.

The results in Measurement Set No. 2 were remarkably similar considering the vast difference in the design of the two analyzers. Although the measurements were relatively simple and not very demanding, they represent common spectrum analyzer applications.

Measurement Set No. 3 indicates that, for a span of 20 MHz, the spectra are identical. However, when viewing a single station with the Max Hold trace, the TinySA Ultra's trace noise is much higher than the FPL1003. The FM broadcast station spectra normally smooths out with a Max Hold trace run for several minutes. Both analyzers showed interesting horns about ±60 kHz from the station center frequency, slightly more pronounced in the TinySA Ultra plot, but these would come and go depending on the mostly music broadcast content of the station KBBO.

With respect to these limited measurements, perhaps the most significant difference between the TinySA Ultra and FPL1003 was the sweep time. The FPL1003 was consistently a couple orders of magnitude faster than the TinySA Ultra for the signal measurements and three orders of magnitude faster for the DANL measurements. The faster sweep times of the FPL1003 provide a huge advantage when trying to capture intermittent and short-duration signals. The FPL1003 is not advertised as a real-time spectrum analyzer but it has many features of one, especially at lower resolution bandwidths as seen in these measurements.

---

5. References

{Reeve20a} Reeve, W., Cascaded Filter for the LWA Antenna, 2020. Available at: https://www.reeve.com/Documents/Articles%20Papers/Reeve_LWA-FilterCascade.pdf

{Reeve20b} Reeve, W., Basic Filters and Applications, 2020. Available at: https://www.reeve.com/Documents/Articles%20Papers/Reeve_BasicFilters.pdf

{Reeve25} Reeve, W., TinySA Ultra Spectrum Analyzer Trace Detectors & Bandwidth Settings, 2025. Available at: https://www.reeve.com/Documents/Articles%20Papers/Reeve_TinySA-Trace.pdf

{R&S-FPL} FPL-series Spectrum Analyzers: https://www.rohde-schwarz.com/us/products/test-and-measurement/benchtop-analyzers/fpl-spectrum-analyzer_63493-465280.html

TinySA Ultra weblinks:

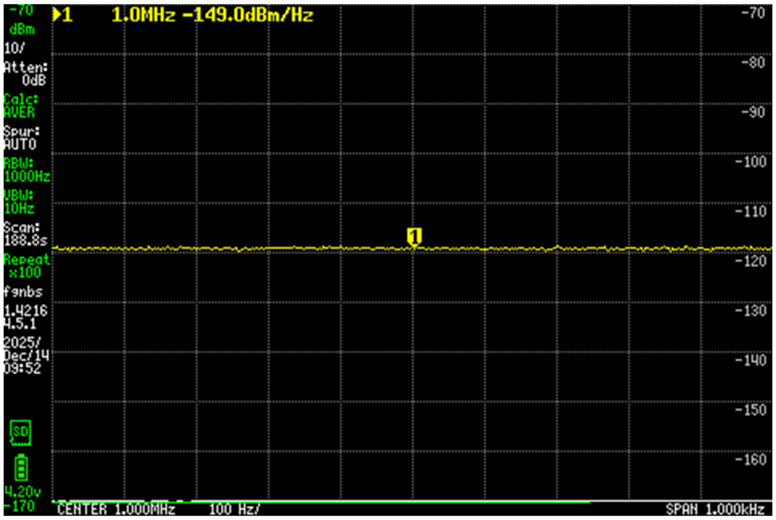
- TinySA on groups.io: https://groups.io/g/tinysa
- TinySA Wiki: https://tinysa.org/wiki/
- TinyRemote screenshot software tool: http://athome.kaashoek.com/tinySA4/Remote/
- TinySA-App software application: http://athome.kaashoek.com/tinySA/Windows/
- TinySA on YouTube: https://www.youtube.com/playlist?list=PL5ZELMM2xseNkwVBtyAG00uZevwWUdVIg
- Description of TinySA a real Spectrum Analyzer for little money, Kurt Poulsen, 2020: https://www.hamcom.dk/TinySA/Description_of_TinySA_a_real_Spectrum_Analyzer_for_little_money.pdf

---

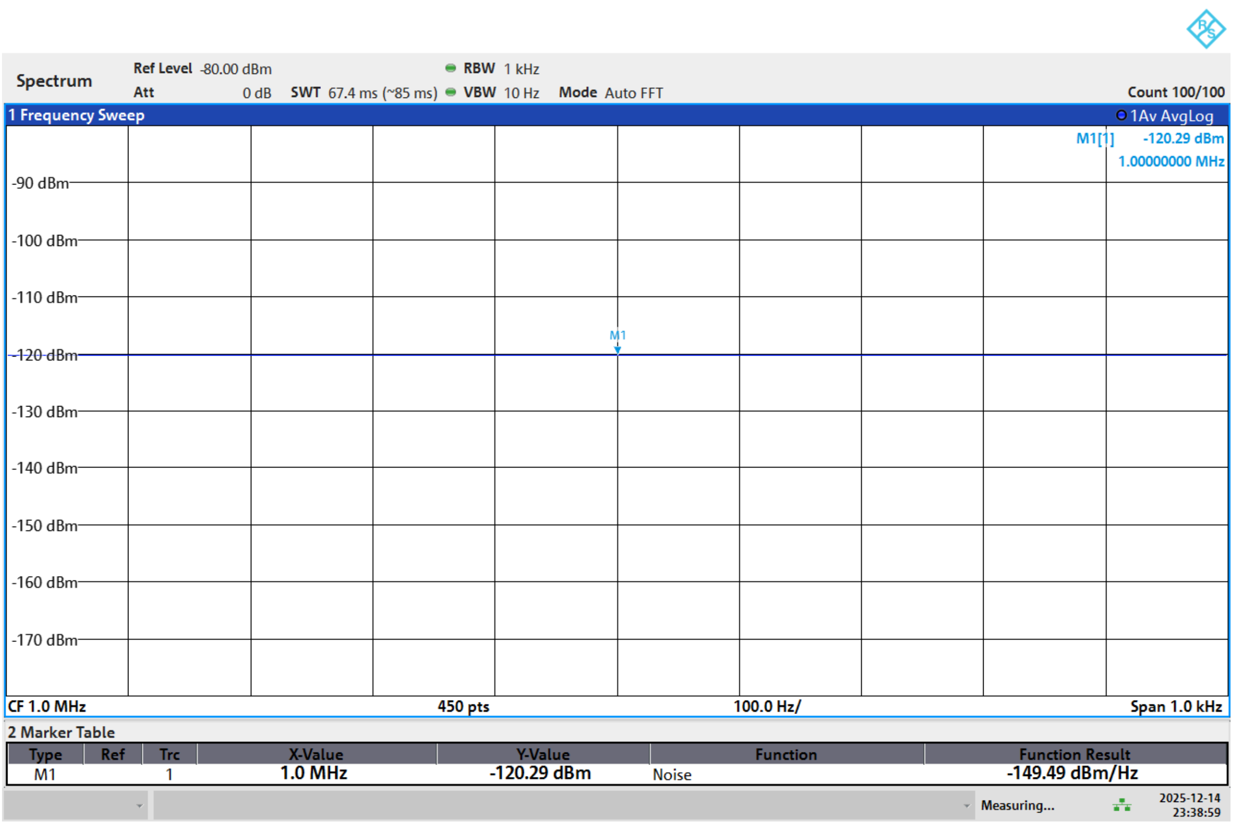
Appendix I ~ Screenshots for Measurement Set No. 1:

Figure A.1.1 ~ 1 MHz

TinySA Ultra, LNA Off:



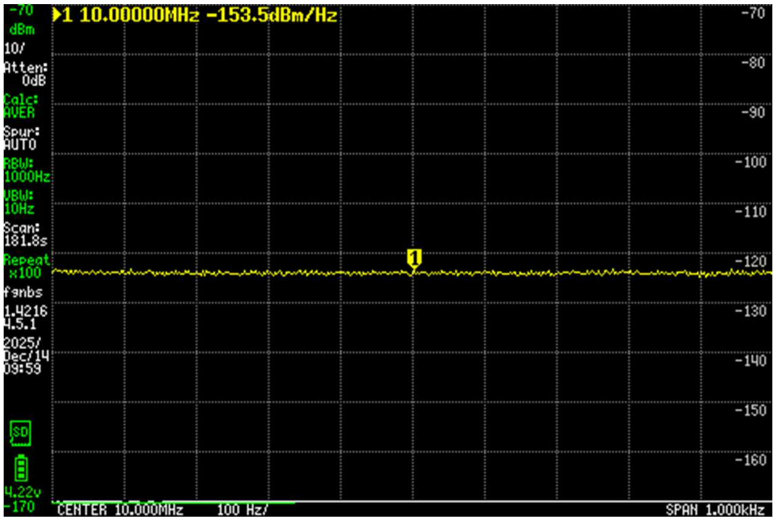
FPL1003, Preamplifier Off:



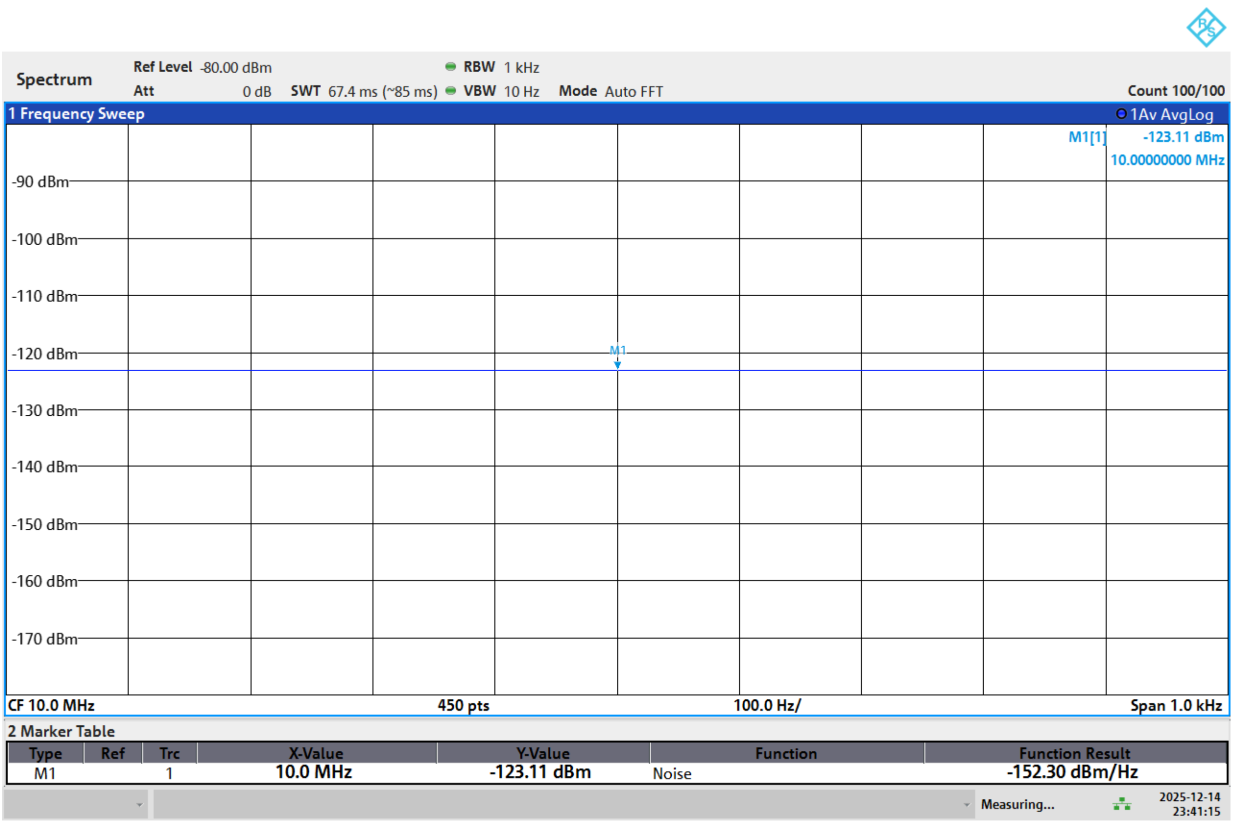
11:39:00 PM 12/14/2025

Figure A.1.2 ~ 10 MHz

TinySA Ultra, LNA Off:



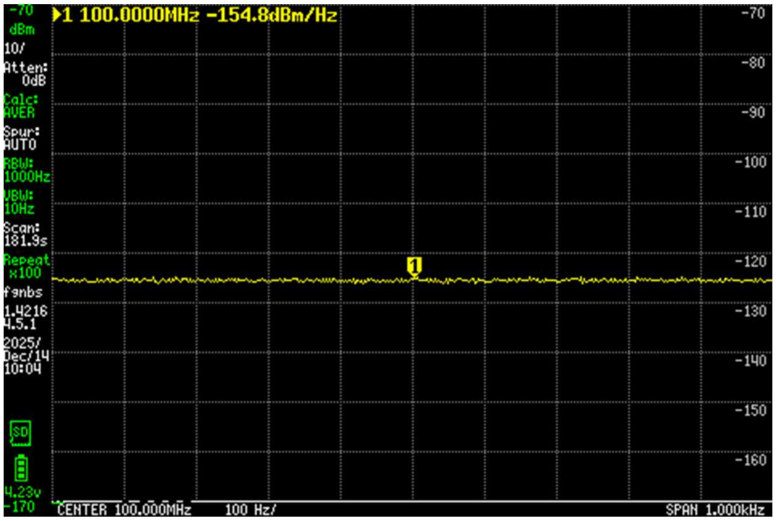
FPL1003, Preamplifier Off:



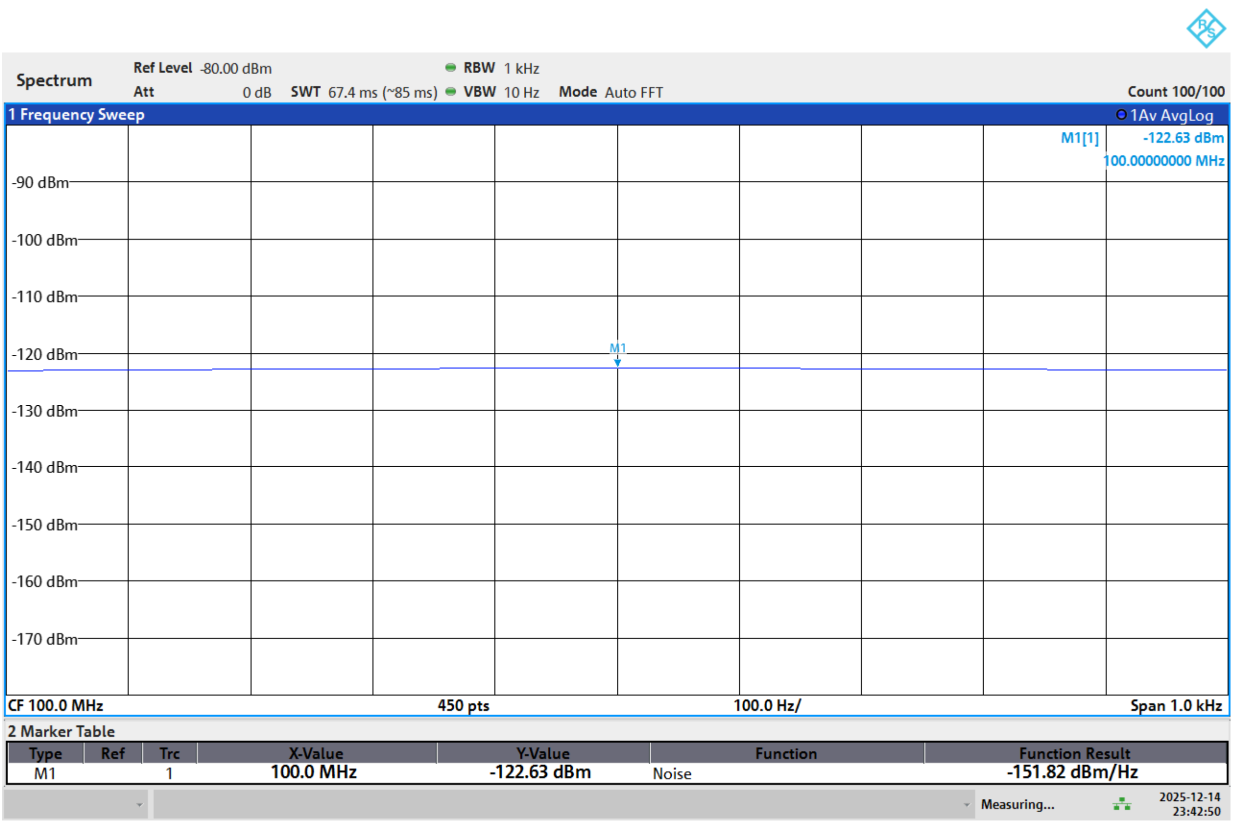
11:41:16 PM 12/14/2025

Figure A.1.3 ~ 100 MHz

TinySA Ultra, LNA Off:



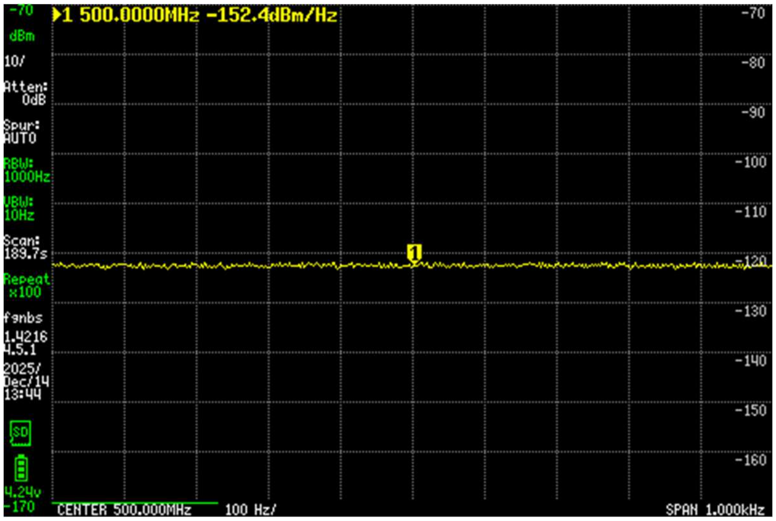
FPL1003, Preamplifier Off:



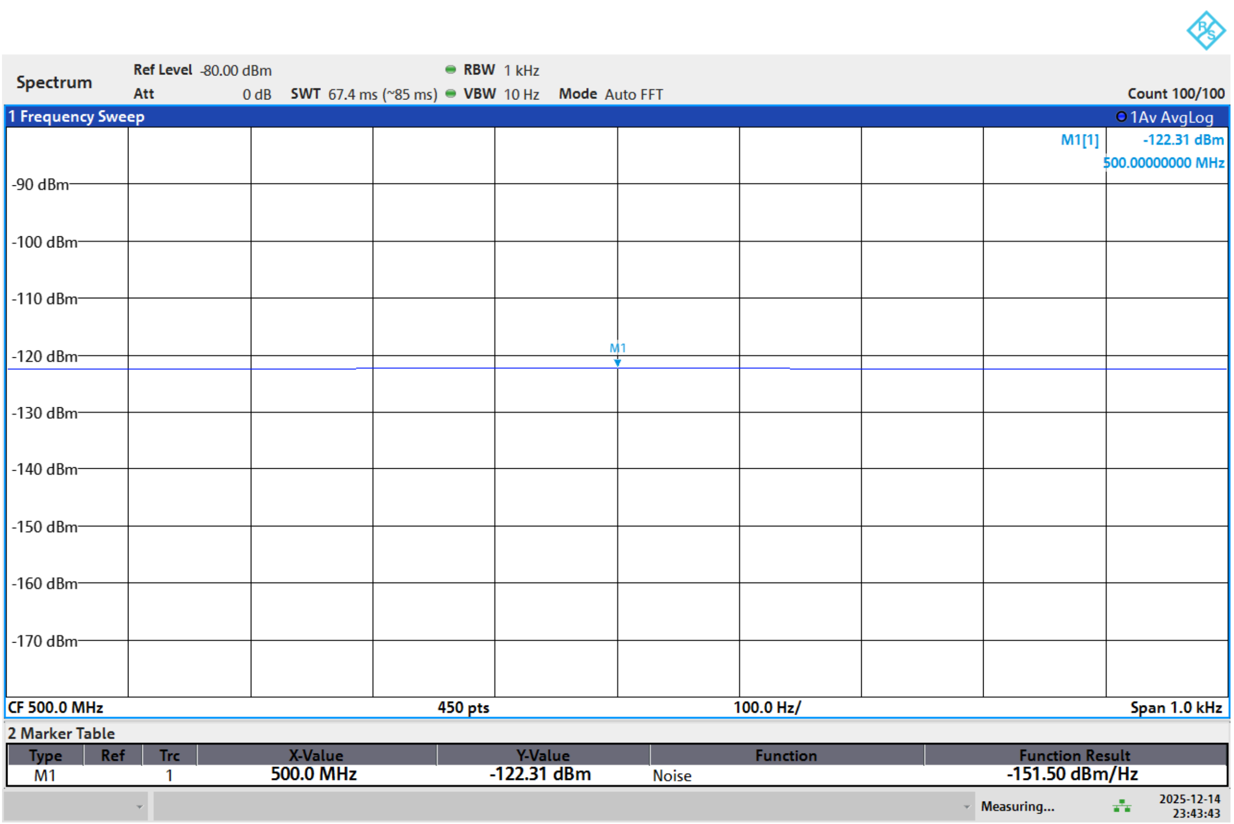
11:42:51 PM 12/14/2025

Figure A.1.4 ~ 500 MHz

TinySA Ultra, LNA Off:



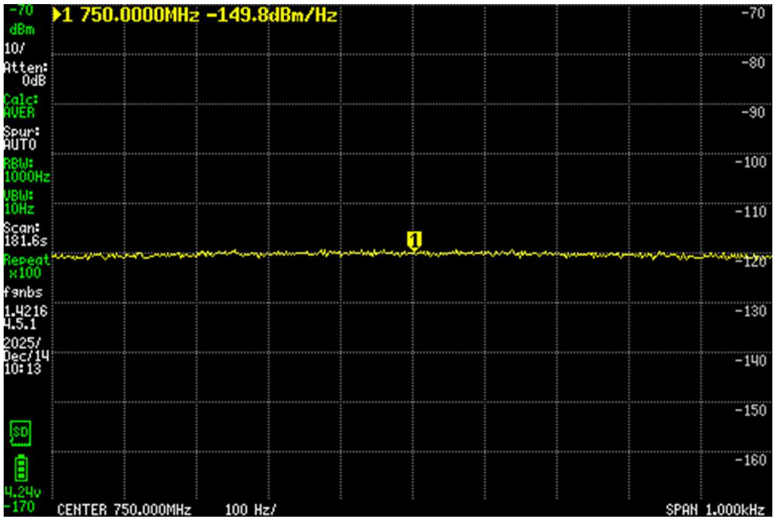
FPL1003, Preamplifier Off:



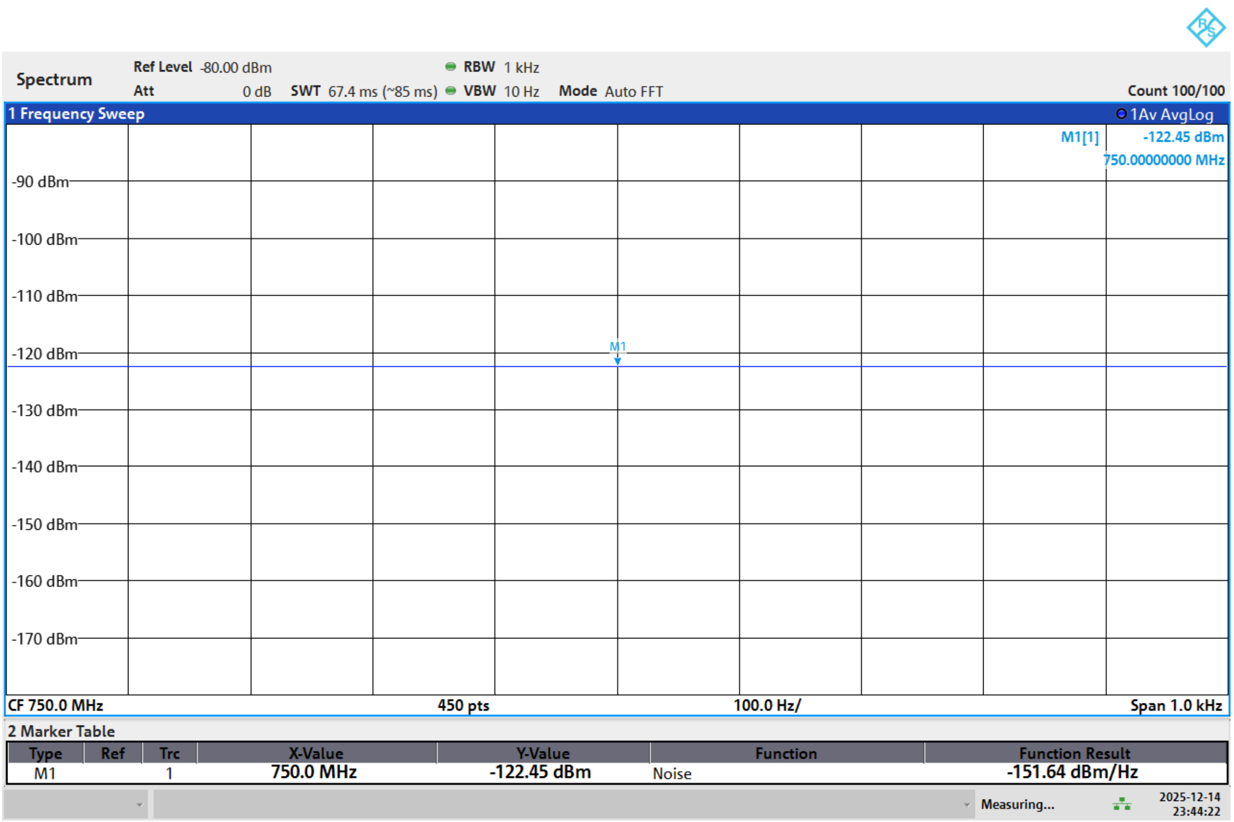
11:43:43 PM 12/14/2025

Figure A.1.5 ~ 750 MHz

TinySA Ultra, LNA Off:



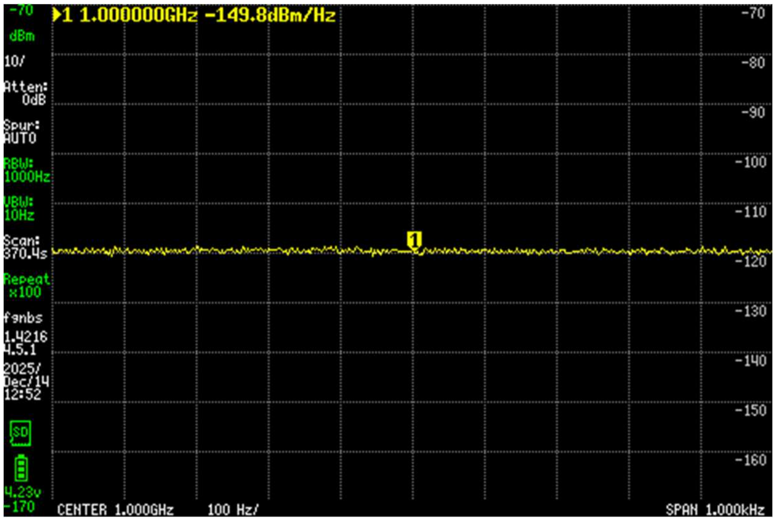
FLP1003, Preamplifier Off:



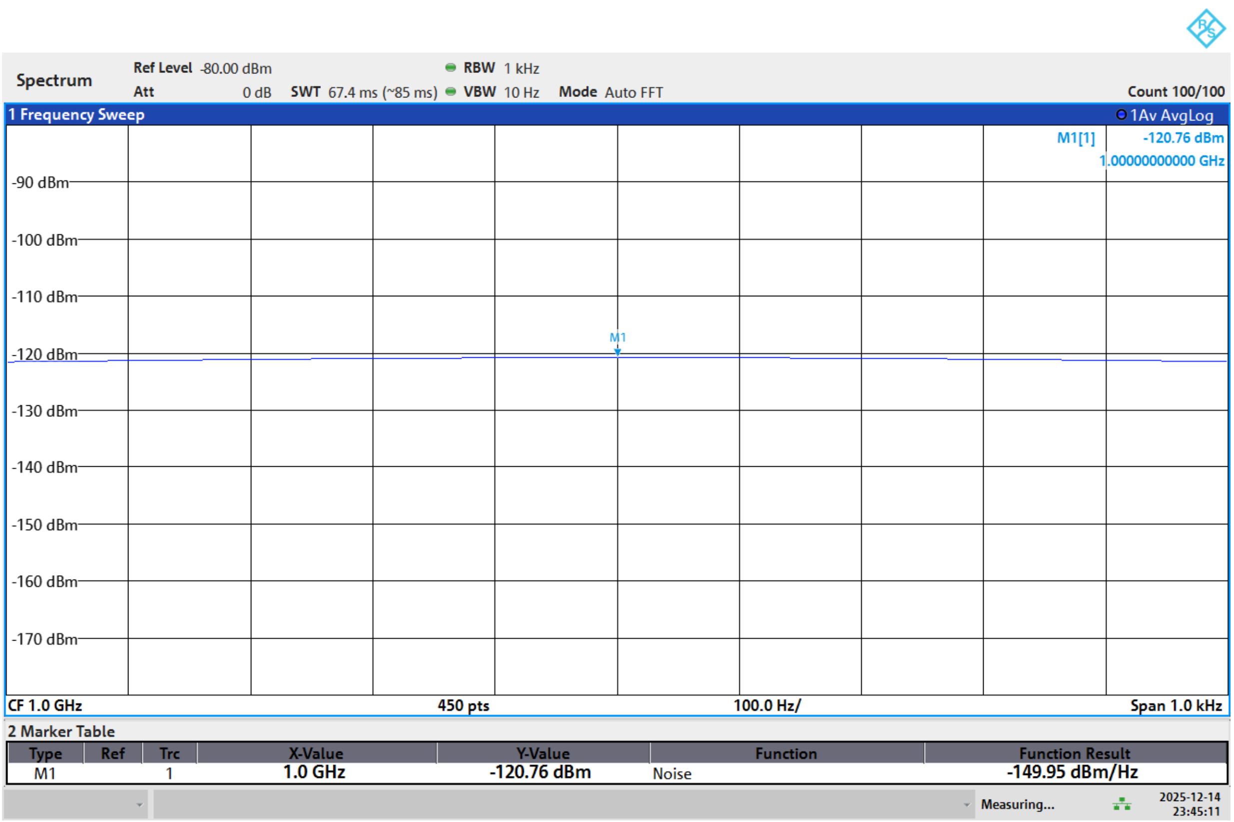
11:44:22 PM 12/14/2025

Figure A.1.6 ~ 1 GHz

TinySA Ultra, LNA Off:



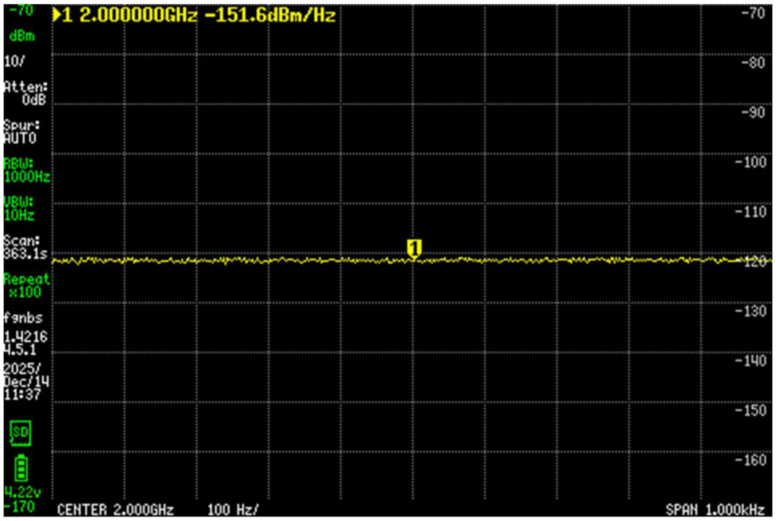
FPL1003, Preamplifier Off:



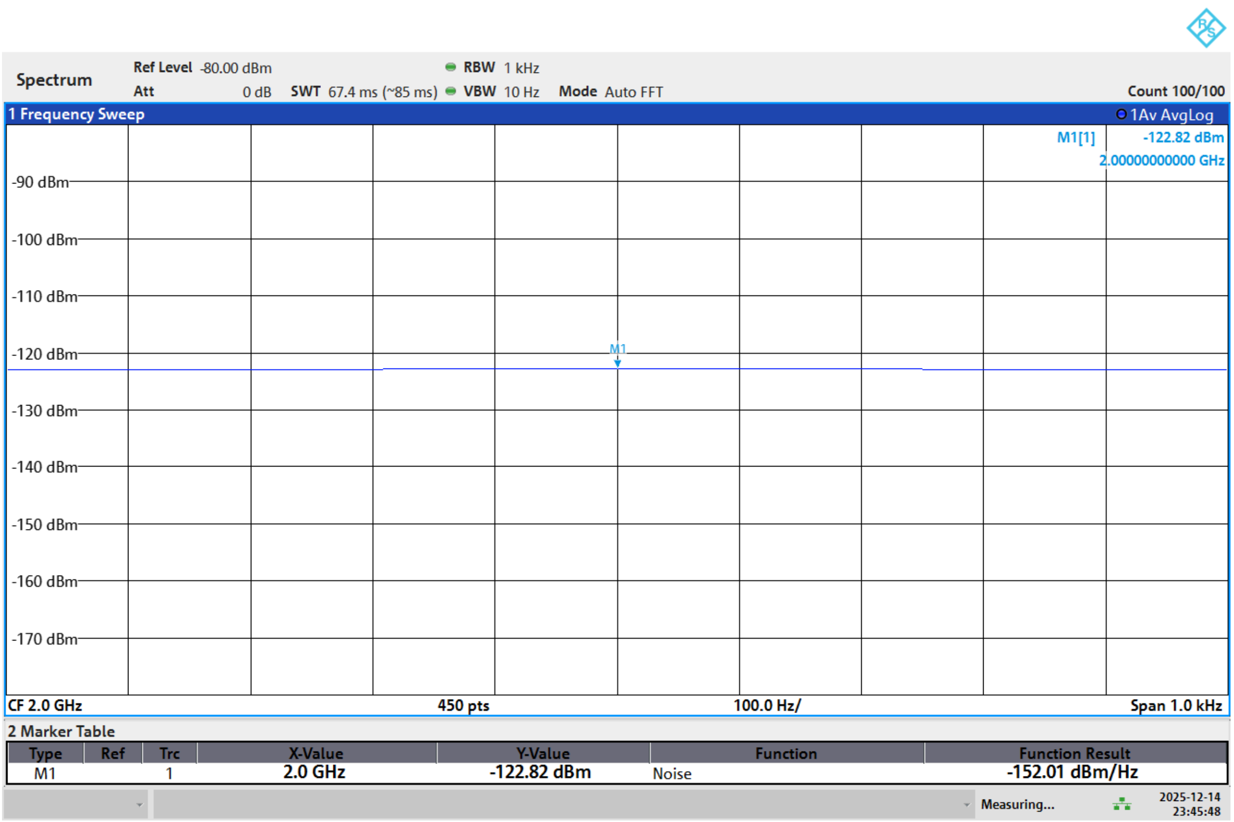
11:45:12 PM 12/14/2025

Figure A.1.7 ~ 2 GHz

TinySA Ultra, LNA Off



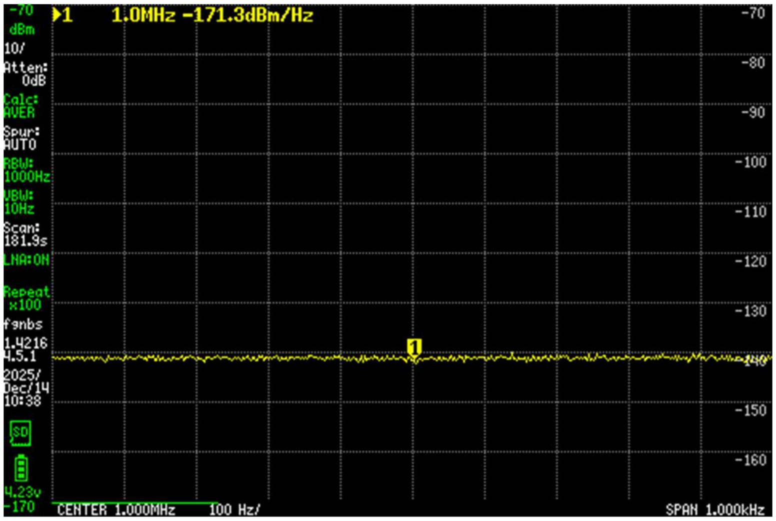
FPL1003, Preamplifier Off:



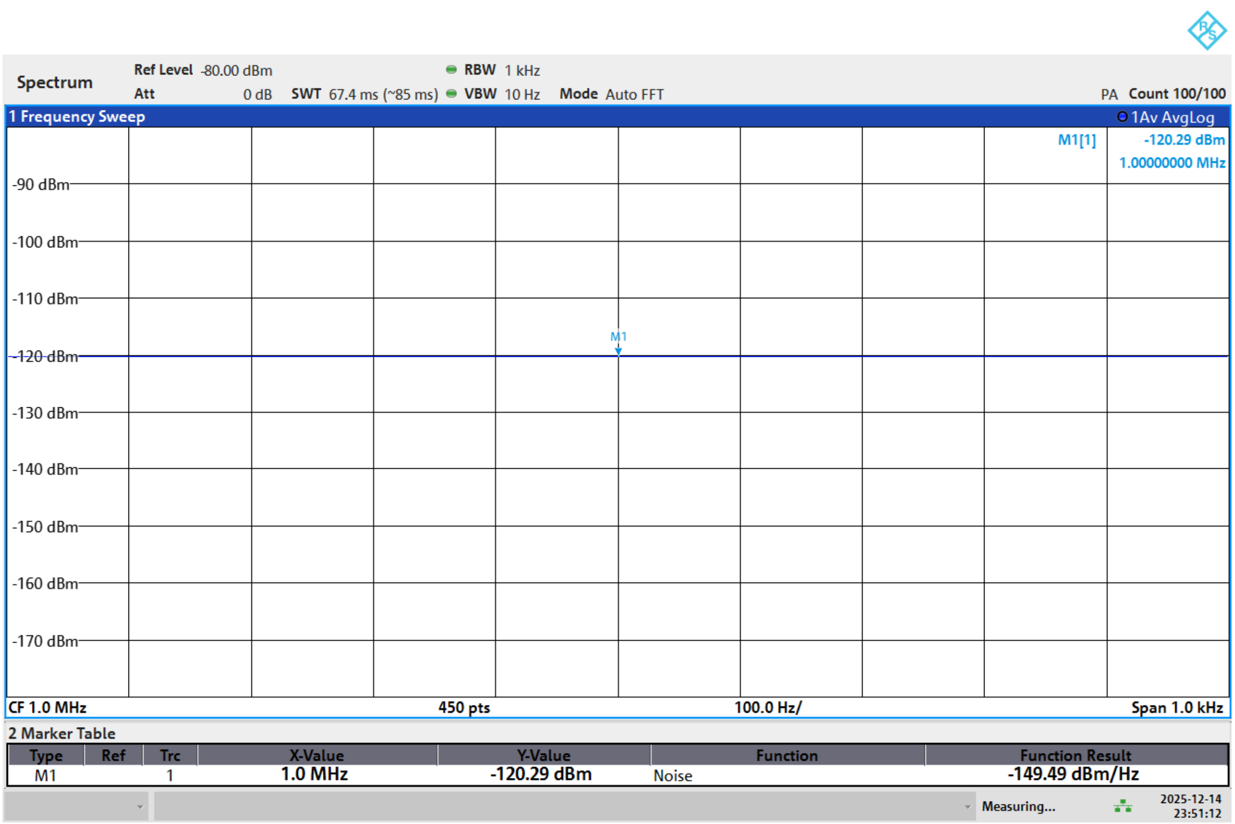
11:45:48 PM 12/14/2025

Figure A.1.8 ~ 1 MHz

TinySA Ultra, LNA On:



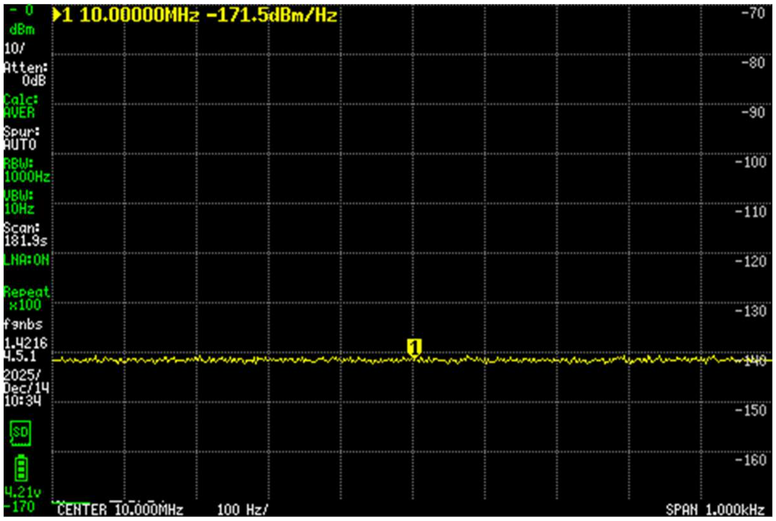
FPL1003, Preamplifier On:



11:51:13 PM 12/14/2025

Figure A.1.9 ~ 10 MHz

TinySA Ultra, LNA On:



FPL1003, Preamplifier On:

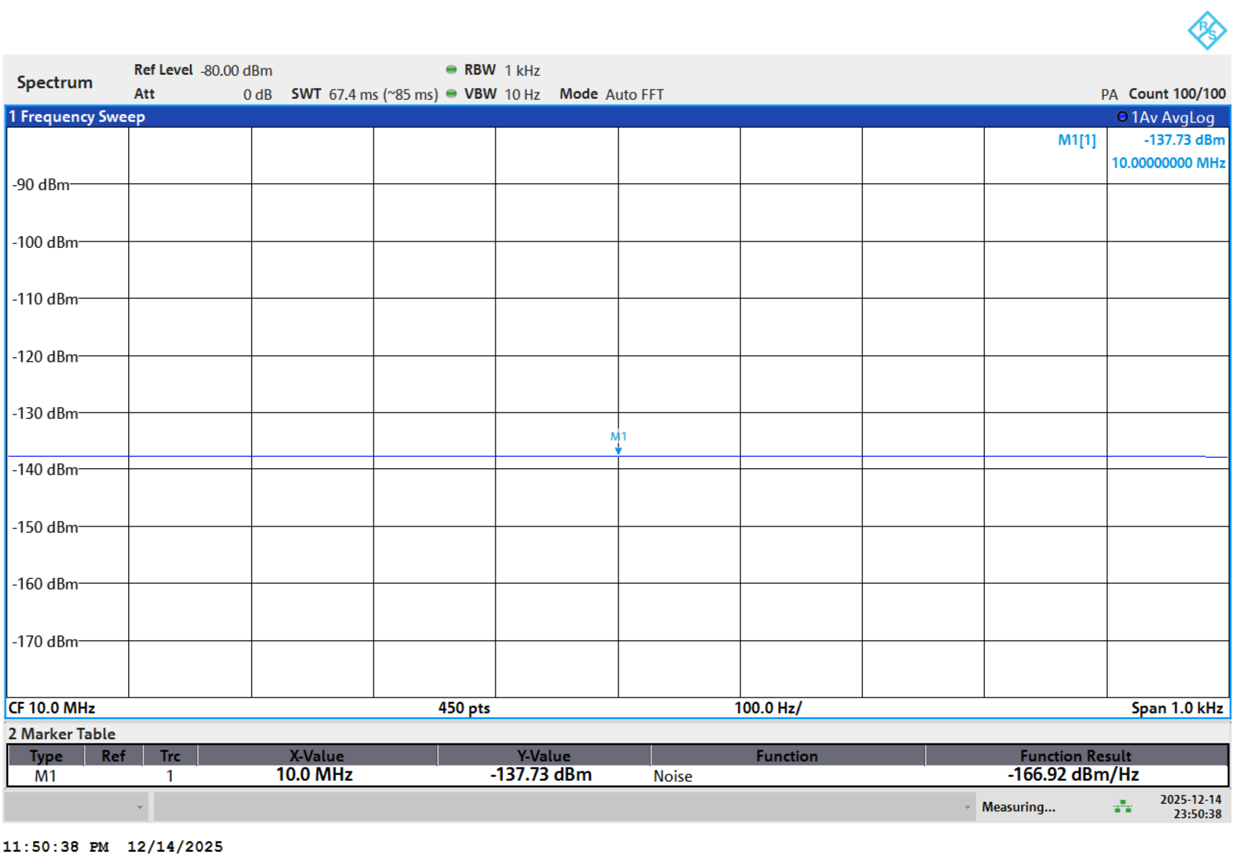
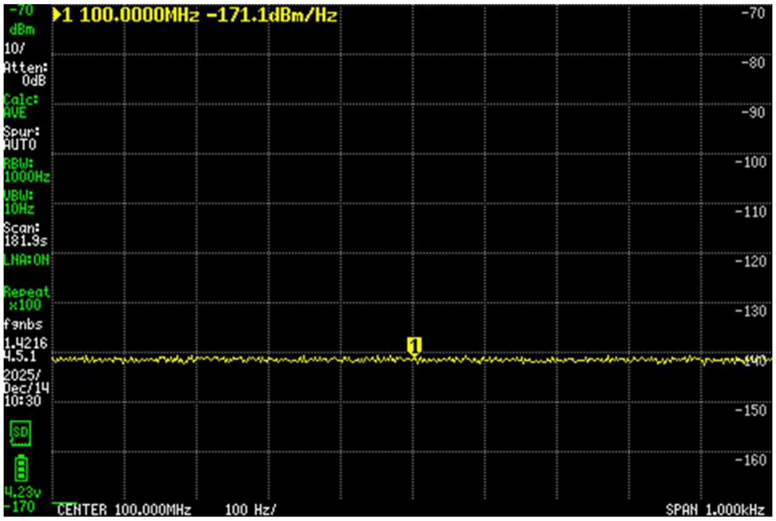
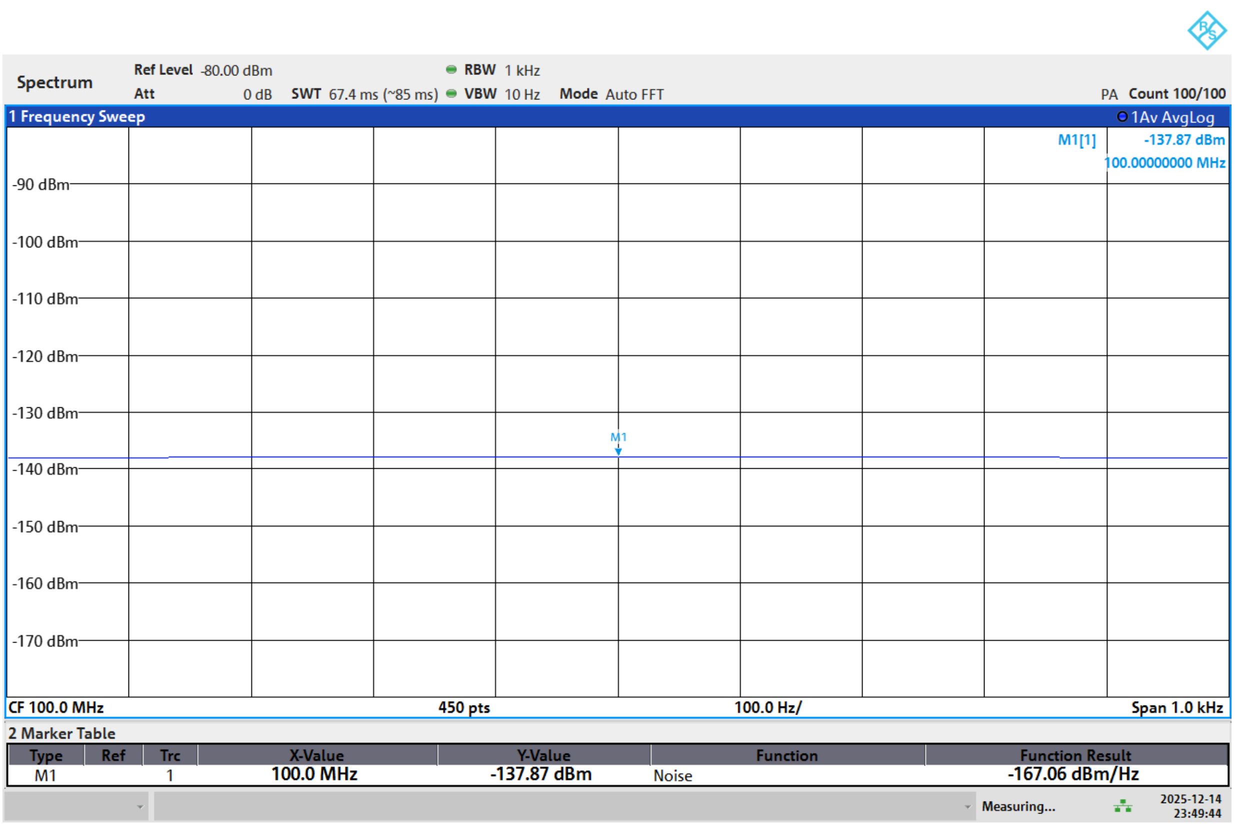


Figure A.1.10 ~ 100 MHz

TinySA Ultra, LNA On:



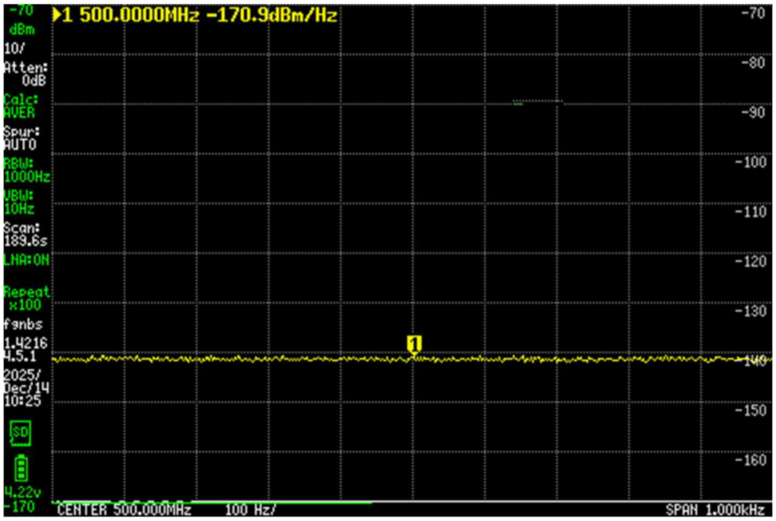
FPL1003, Preamplifier On:



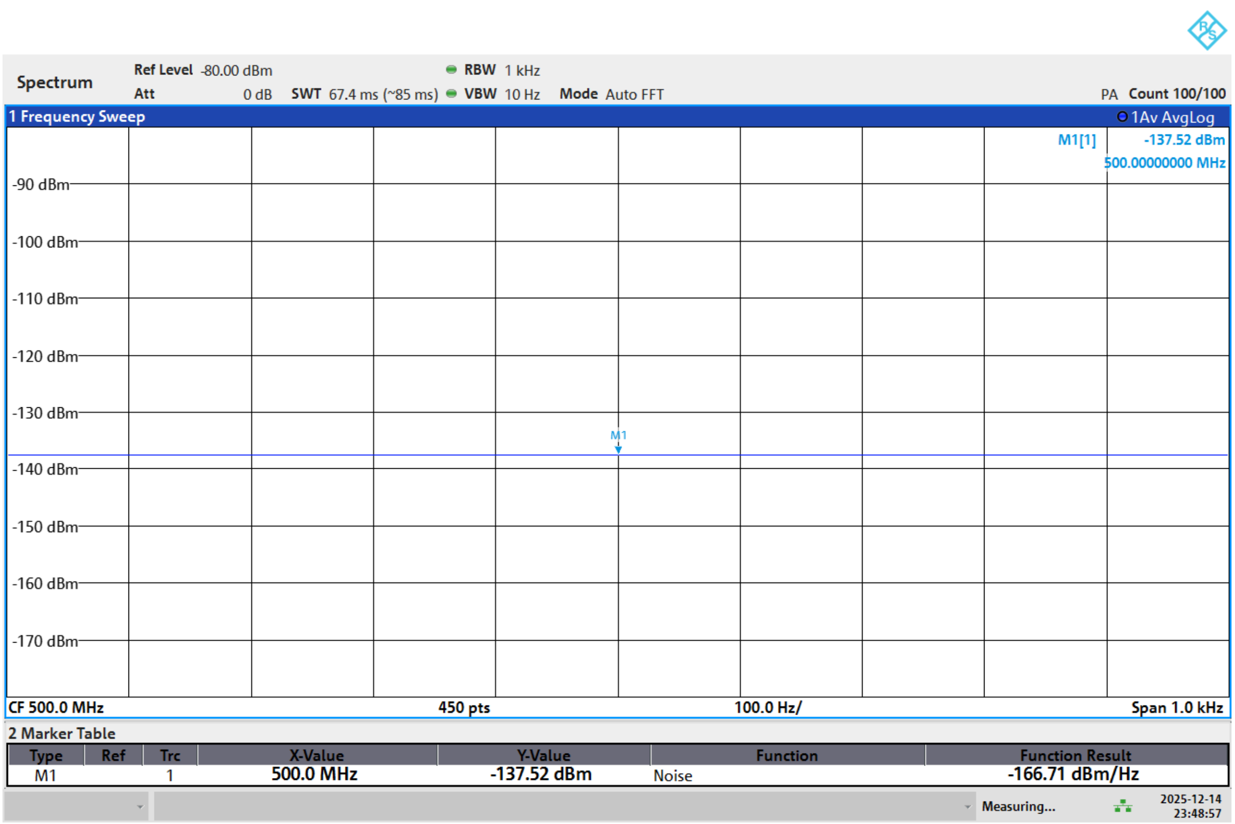
11:49:45 PM 12/14/2025

Figure A.1.11 ~ 500 MHz

TinySA Ultra, LNA On:



FPL1003, Preamplifier On:

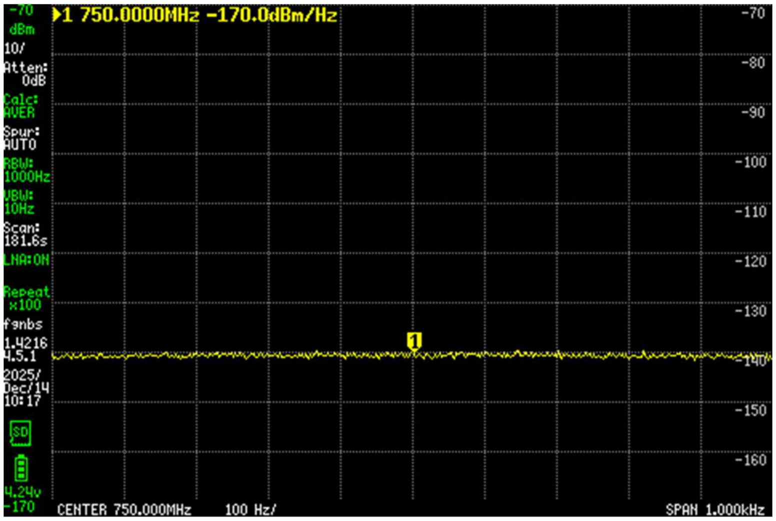


Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	500.0 MHz	-137.52 dBm	Noise	-166.71 dBm/Hz

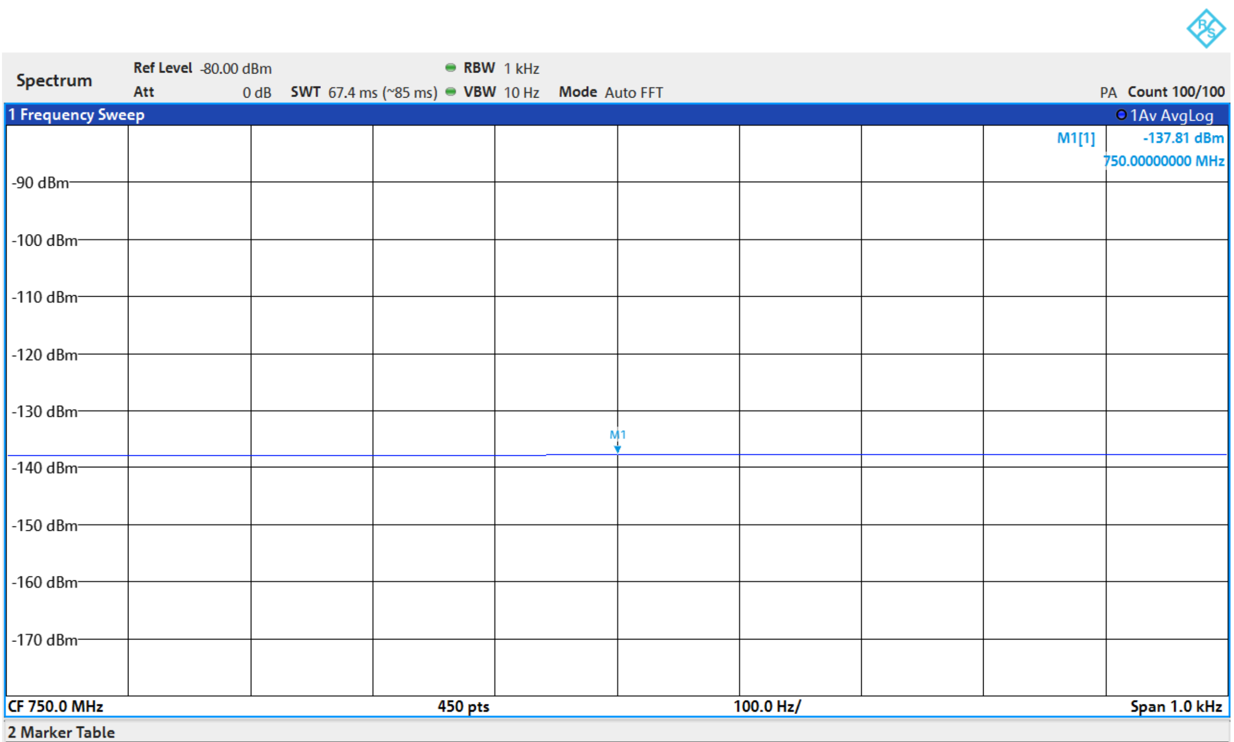
11:48:58 PM 12/14/2025

Figure A.1.12 ~ 750 MHz

TinySA Ultra, LNA On:



FPL1003, Preamplifier On:

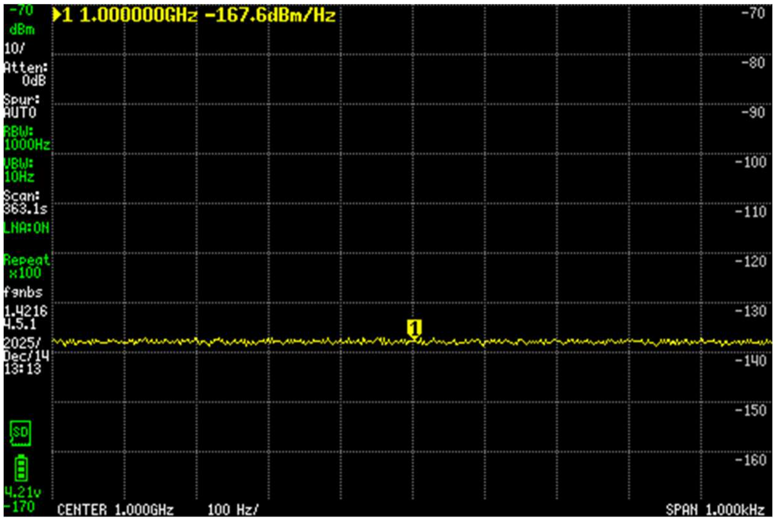


Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	750.0 MHz	-137.81 dBm	Noise	-167.00 dBm/Hz

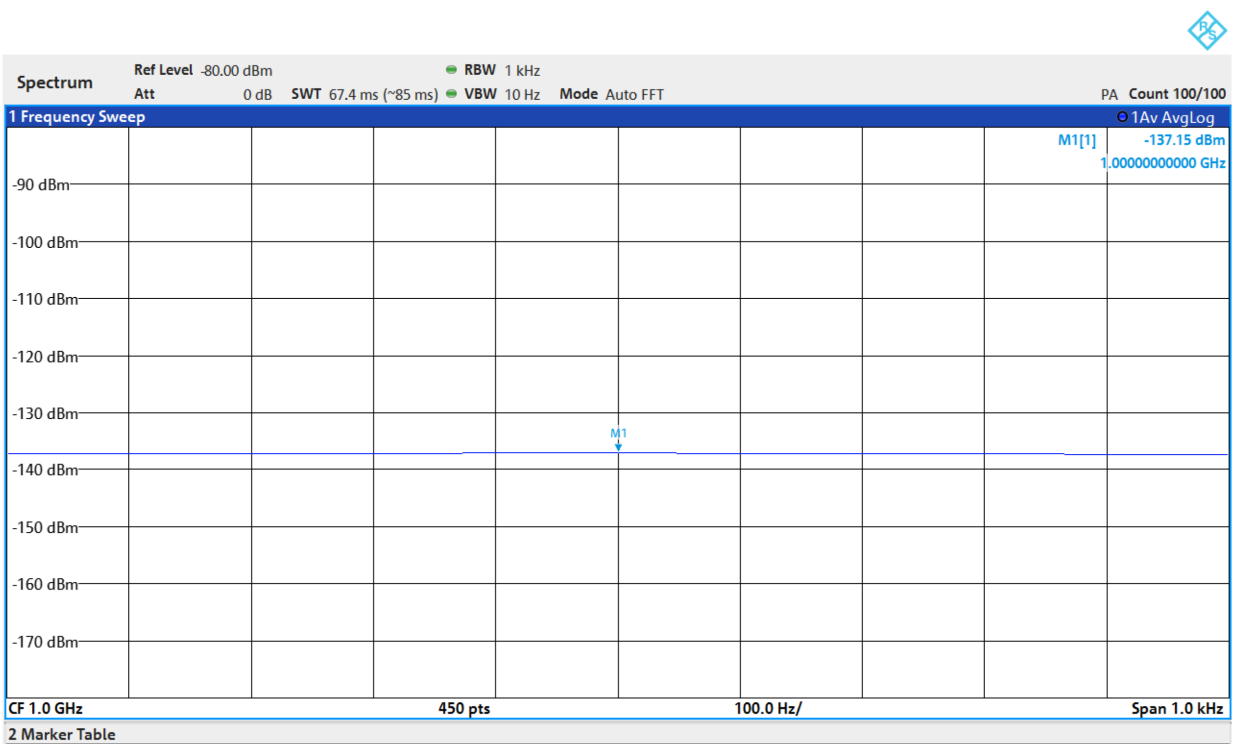
11:48:19 PM 12/14/2025

Figure A.1.13 ~ 1 GHz

TinySA Ultra, LNA On:



FPL1003, Preamplifier On:

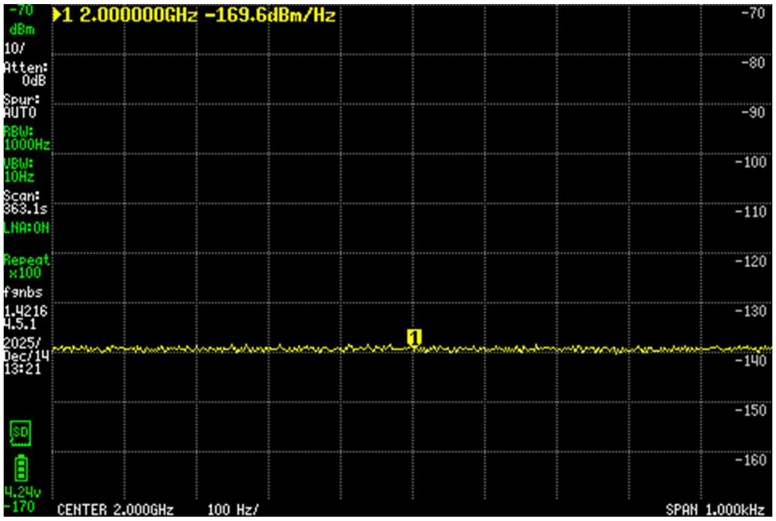


Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	1.0 GHz	-137.15 dBm	Noise	-166.34 dBm/Hz

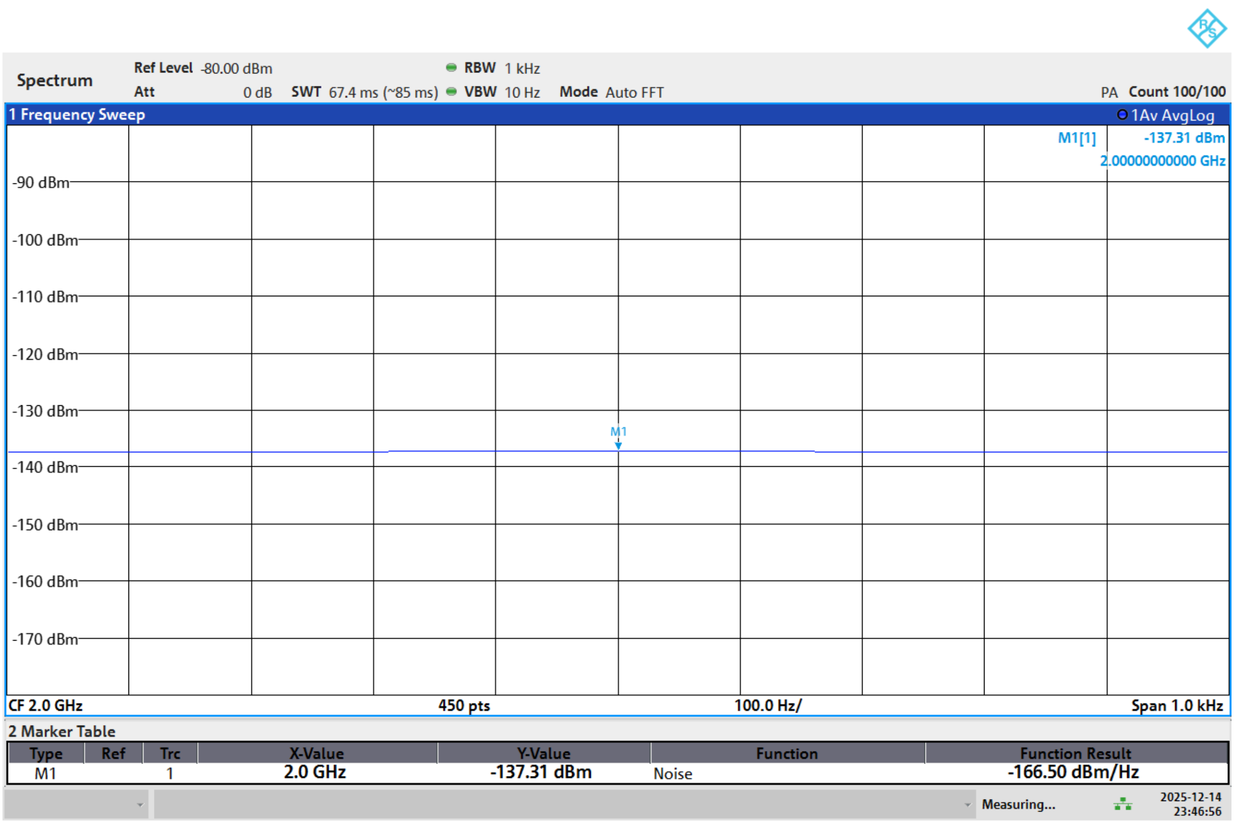
11:47:36 PM 12/14/2025

Figure A.1.14 ~ 2 GHz

TinySA Ultra, LNA On:



FPL1003, Preamplifier On:



Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	2.0 GHz	-137.31 dBm	Noise	-166.50 dBm/Hz

11:46:56 PM 12/14/2025

Document Information

Author: Whitham D. Reeve

Revisions: 0.0 (Started document, 08 Dec 2025)

0.1 (TinySA Ultra DANL measurements, 13 Dec 2025)

0.2 TinySA Ultra & FPL1003 DANL measurements, 14 Dec 2025)

0.3 (Added measurement set 2 description, 15 Dec 2025)

0.4 (Signal measurements, images & details, 17 Dec 2025)

0.5 (Completed measurement set 2 and tables, 18 Dec 2025)

0.6 (Rearranged measurement set 1 images in appendix, 19 Dec 2025)

0.7 (Revised text in all sections, 20 Dec 2025)

0.8 (Minor edits, 21 Dec 2025)

0.9 (Added measurement set 3 and description, 23 Dec 2025)

1.0 (Edits, 25 Dec 2025)

1.1 (Prepared for distribution, 25 Jan 2026)

1.2 (Distribution, 26 Jan 2026)