# Using Handheld Spectrum Analyzers to Find Hidden Signals

## Introduction

High performance handheld spectrum analyzers are ideal for detecting and locating hidden transmitters because you can easily carry the instrument when hunting for the transmitter and use it to find many types of hidden transmitters that may be difficult or impossible to even detect with lower performance tools.


*Figure 1. Anritsu Handheld Spectrum Analyzer, MS2725C, 9 kHz to 32 GHz*

Placing a bug near a high level signal can be a very effective way to make it very difficult to detect. There are several potential reasons for this. Most handheld spectrum analyzers exhibit fairly poor phase noise characteristics. These phase noise skirts are very effective at hiding a transmitter. Failure to have sufficiently narrow resolution bandwidth filters makes it impossible to detect signals close to a strong carrier. The ability to sweep quickly also provides major benefit since you can to a wide sweep without taking a long time. For example, you can use the Anritsu MS2722C to get a 9 GHz sweep in less than 0.5 seconds. Those limitations in many instruments make them ineffective for finding this sort of hidden transmitter.

Since sweep speed is often a big concern, a new way of sweeping was developed for the C- and E-series of spectrum analyzers. It is called “Fast Sweep” and delivers sweep times that increase only slightly as the resolution bandwidth is narrowed. As an example, for a 500 MHz span this table shows the sweep speeds for the Fast mode on the MS2722C and MS2713E and the traditional sweep speed on an MS2721B. All other settings are at their default values. You will note that the sweep time for a 1 kHz RBW on the MS2722C is 15 times faster than the sweep time on the MS2721B, a major speed advantage.

| RBW | MS2722C Sweep time | MS2713E Sweep time | MS2721B Sweep time |
|---|---|---|---|
| 3 MHz | 135 ms | 254 ms | 102 ms |
| 1 MHz | 133 ms | 625 ms | 203 ms |
| 300 kHz | 133 ms | 1.88 s | 912 ms |
| 100 kHz | 332 ms | 608 ms | 2.9 s |
| 30 kHz | 532 ms | 1.99 s | 18 s |
| 10 kHz | 900 ms | 3.97 s | 16.6 s |
| 3 kHz | 2 s | 16 s | 51 s |
| 1 kHz | 9 s | 33 s | 143 s |

With a spectrum analyzer with low phase noise you can search for signals near a strong carrier with confidence that such a transmitter can be found. For example, if a bug is placed very near the carrier of a strong AM signal, a spectrum analyzer with poor phase noise will not be able to see it.

Here is a narrow band view of an AM signal shown with 3 different resolution bandwidths.

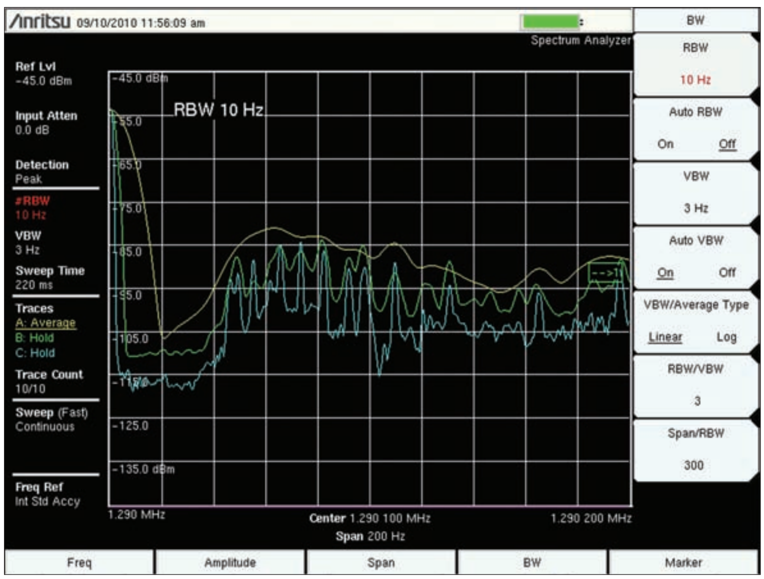


*Figure 2. Effects of narrow RBW limitations.*

By using 1 Hz RBW, the blue trace, It is not only easy to see power-line related sidebands, but if there is a signal hidden in the area between the carrier (on the left edge of the screen) and the 60 Hz hum sideband, it would be easy to see. The area from the AM carrier at the left edge of the screen and the 60 Hertz hum sideband would be invisible to a handheld instrument with lesser phase noise performance, limited dynamic range or limited resolution bandwidth choices.

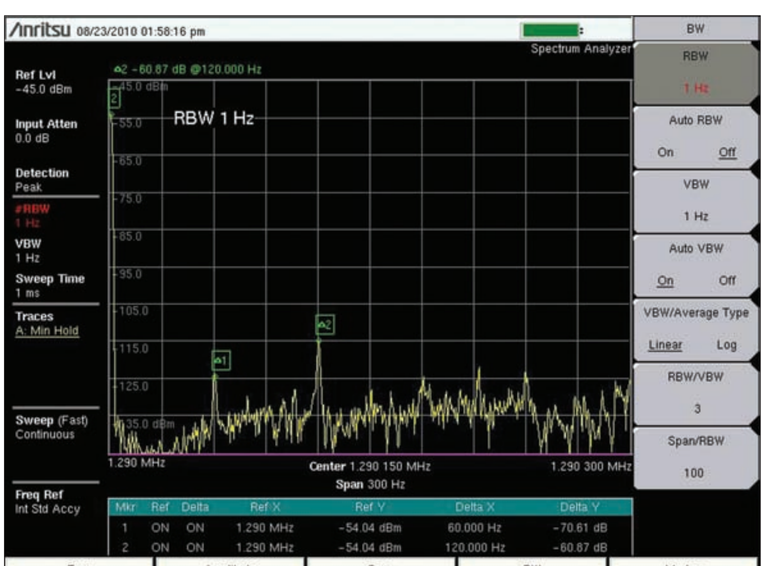


*Figure 3. Close-in AM signal measurement made using a 1 Hertz resolution bandwidth. The carrier is at the left edge of the screen.*

If the narrowest available resolution bandwidth were 100 Hertz, or even 30 Hz, there would be no way to make this measurement. Even a 10 Hertz RBW isn't good enough to do the job. See figures 2 and 4.

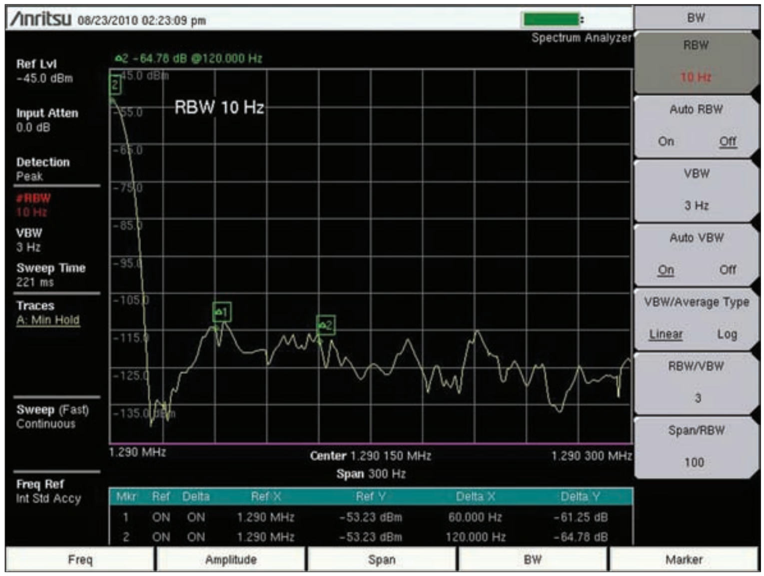


*Figure 4. AM carrier measured with 10 Hz RBW*

You need wide dynamic range so you can detect tiny signals in the presence of huge signals. In this measurement the 60 Hz delta marker is at -70 dBc, beyond the dynamic range of many handheld instruments. This is important because there may be large signals near the frequency of a hidden transmitter.

Flexibility in the selection of resolution bandwidth and video bandwidth are important for hidden transmitter hunting.

You can use a wide resolution bandwidth to go fast during an initial sweep for a hidden transmitter and if necessary you can use a narrow resolution bandwidth to get a low noise floor. With the new fast sweep capabilities of the MS272xC and MS271xE you can get a low noise floor (great sensitivity) without having to suffer through very long sweep times.

As shown in figures 5 and 6, by using narrow video bandwidths you can smooth out noise on a trace and makes signals near the noise floor more visible, that way you can be sure they are real signals, not just random noise spikes. On the live trace the signal in figure 5 was bouncing up and down just like the noise was doing. It would not be spotted as a signal.

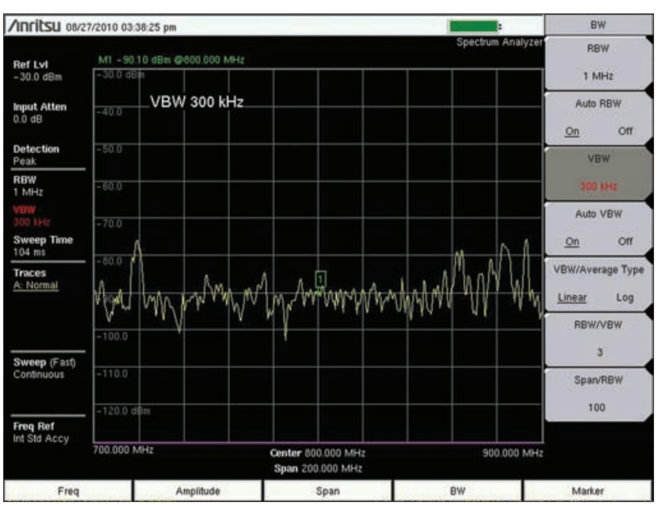


*Figure 5. Small signal can't be seen with the default VBW*

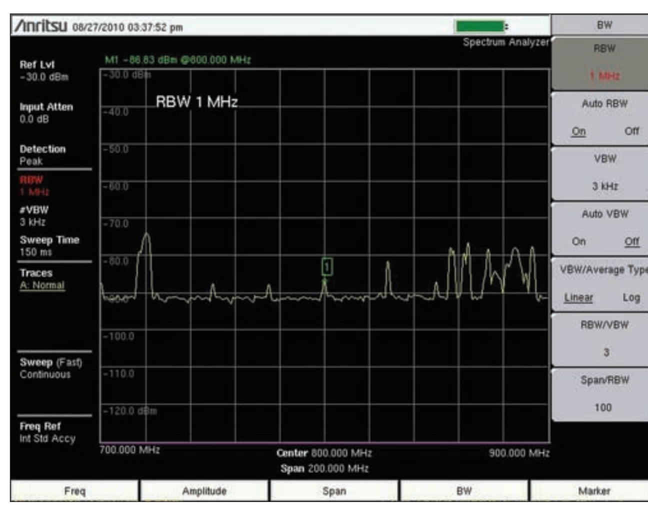


*Figure 6. Narrow VBW clearly reveals the signal*

There are several detector choices in Anritsu handheld spectrum analyzers. Of these, the peak, minimum and average detectors are useful for hidden transmitter hunting. These detectors can be combined with several trace display choices to help discover signals that are trying to hide.

The instrument usually makes several measurements made at slightly different frequencies for each display point. The number of measurements depends primarily on the RBW and the span. There are 551 data points across the screen; to make sure that there are no gaps in the frequency coverage, there are enough measurements taken so all frequencies in the span are measured. The number of measurements needed to do this depends primarily on the resolution bandwidth. The measurements are placed in one of the 551 display "buckets" for processing.

The detectors process the collected data points in different ways. The Peak detector displays the maximum signal for each display point, the Minimum detector displays the smallest signal for each display point while the RMS Average detector calculates and displays the average signal level for each display point.

There are several ways that trace data can be handled in the instrument. By combining the ways traces can be displayed with the detector options, you have a very flexible instrument that can be set to help sort out the interesting signals from all the rest. The trace options are Normal, Max Hold, Min Hold & Average, copy trace A to trace B, copy trace A to trace C, swap traces B and C.

You can use trace math functions to subtract one trace from another. This can sometimes reveal hidden signals, especially if one of the traces is a max hold trace and the other is a min hold trace. Using trace math you can have the instrument subtract Trace B from Trace A (or subtract Trace A from Trace B) and show the results in Trace C.

You can combine the **peak** detector with the **Min Hold** trace setting. By doing this, signals that are present continuously will remain visible while signals that come and go will drop away. By combining the peak detector with the **Max Hold** trace setting any signal that is observed, even once, will remain visible. This can be a good way to catch bursty or intermittent signals.

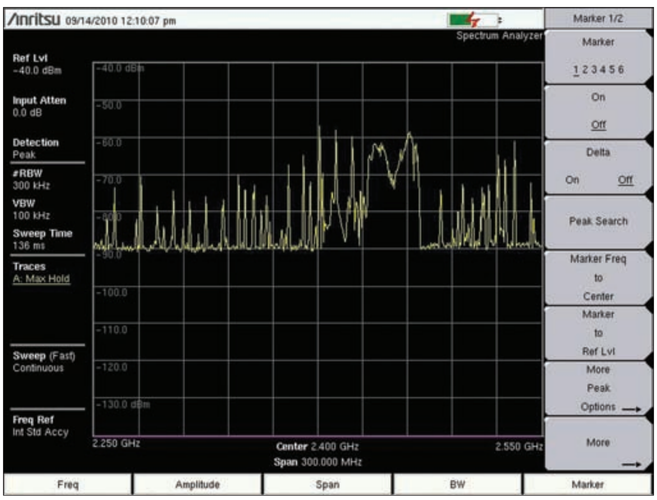


Figure 7. Peak Detector with Max hold

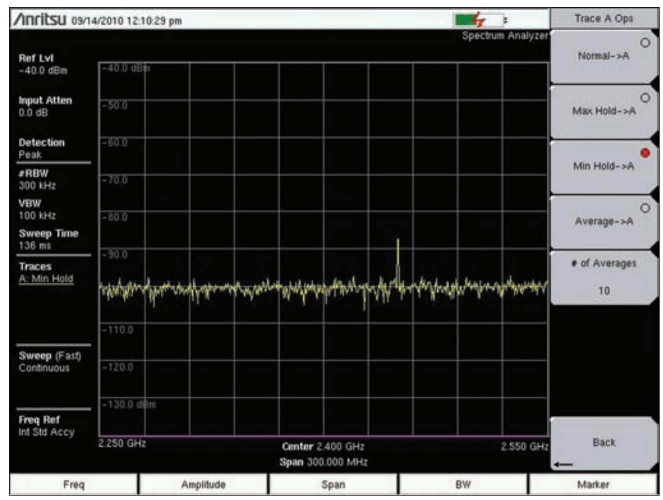


Figure 8. Peak detector with Min hold

You can combine the negative detector with the Min Hold trace setting. Signals that are present continuously will remain visible while signals that come and go will drop away. For this to work, the signal that you are interested in must be *continuously* above the noise floor. The noise floor tends to drop by about 15 dB for a reasonably wide video bandwidth allowing you to see signals that are otherwise buried in the noise.

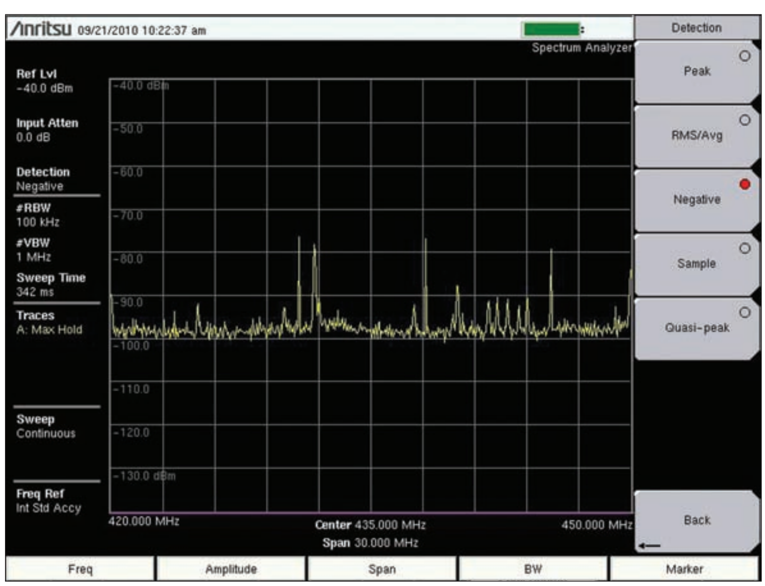


Figure 9. Negative detector with Max hold

By combining the negative detector with the Max Hold trace setting, any signal that is observed, even once, will remain visible. This is a good way to catch bursty signals and is also useful for spectrum usage surveys. The noise floor tends to be about 3 dB lower than with peak detection, giving a minor sensitivity advantage. The spectrum shown in figure 9is occupied primarily by repeaters that are on the air for relatively short periods of time. With this method it is easy to see all the signals that popped up, even briefly.

These two methods works best with reasonably wide video bandwidths – meaning a video bandwidth that is equal to or greater than the resolution bandwidth. The larger noise variation is an advantage in this case since the variation causes the max hold or min hold to get to stable values more quickly, thereby revealing steady-state signals that are otherwise hard to see because of the noise.

In summary, here are the steps to detect small signals

1. Turn on the preamplifier
2. Use a smaller number of dB per division
3. Use Averaging
4. Use a linear display choice – watts or volts to make differences bigger
5. Use trace math to make signals more obvious

Here is an example where there might be something there.

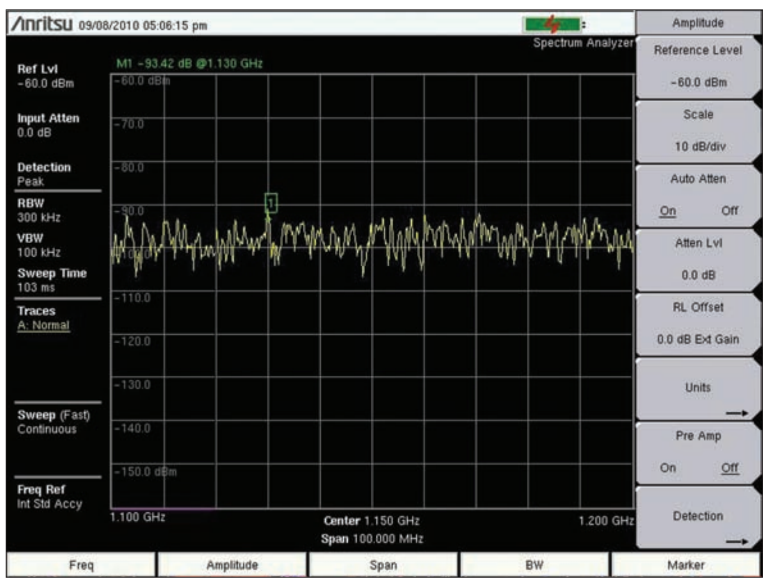


*Figure 10. There might be a small signal there.*

First, turn on the preamplifier. This lowers the noise figure significantly – as much as 25 dB for some instruments.

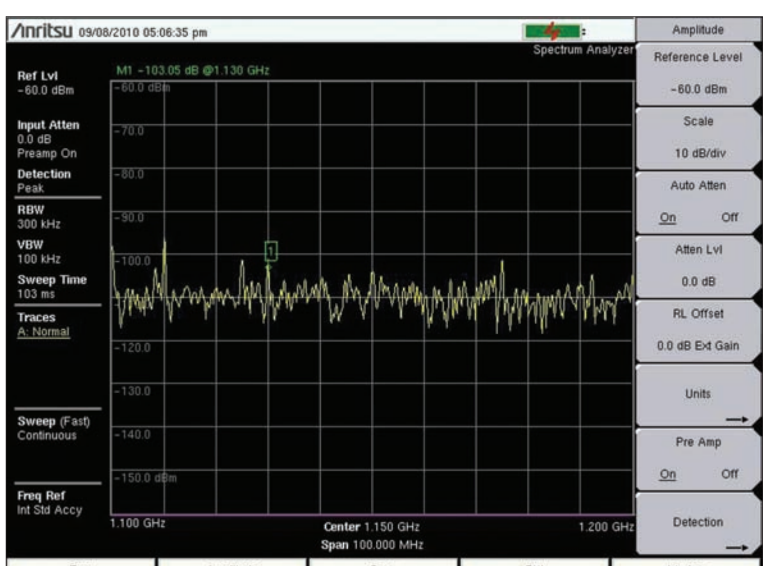


*Figure 11.With the preamplifier on the signal can be seen.*

You can use trace averaging or a narrower video bandwidth to clean up the noise. Generally the net sweep speed will be faster by using a narrower video bandwidth rather than taking several sweeps when averaging.

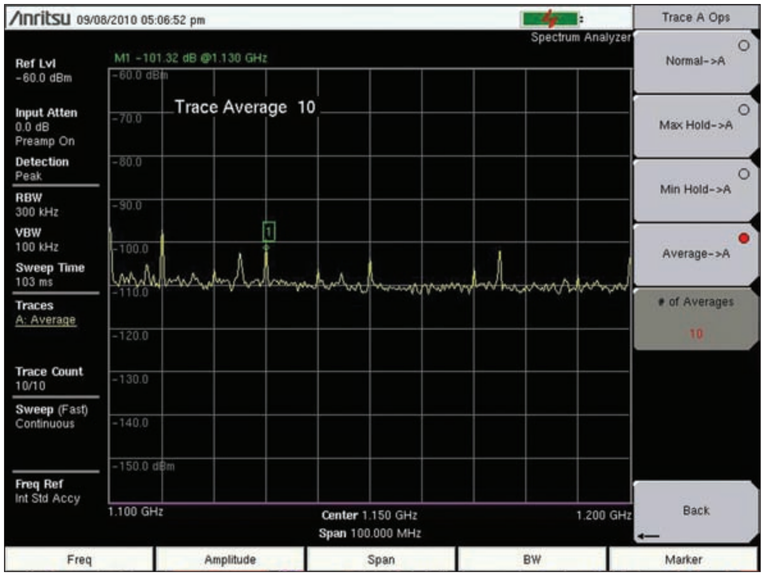


*Figure 12. Trace averaging helps to clean up the trace*

Use a narrower video bandwidth to further clean-up the noise. This doesn't improve sensitivity, but does smooth out the noise floor, making small signals more obvious.

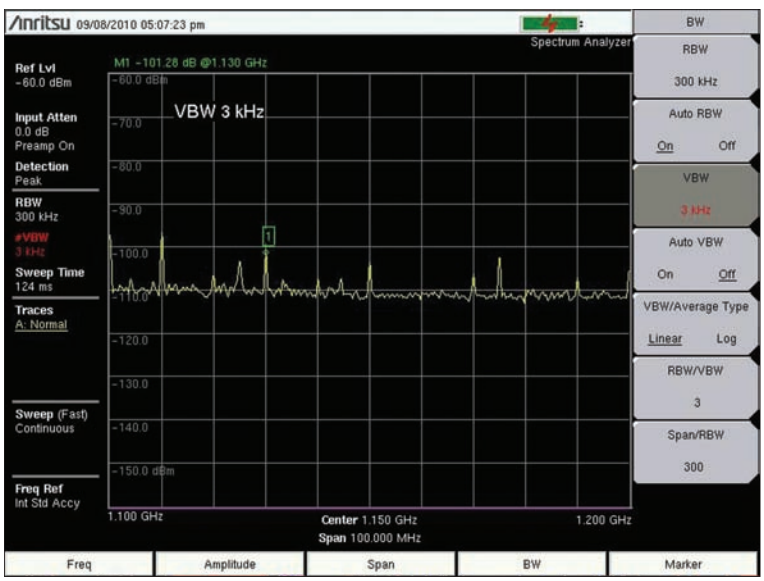


*Figure 13. Narrow video bandwidth also helps clean up the trace*

Spread out the signal vertically by changing the scale to 5 dB per division. While this doesn't improve sensitivity, it makes small signals "pop out" more.

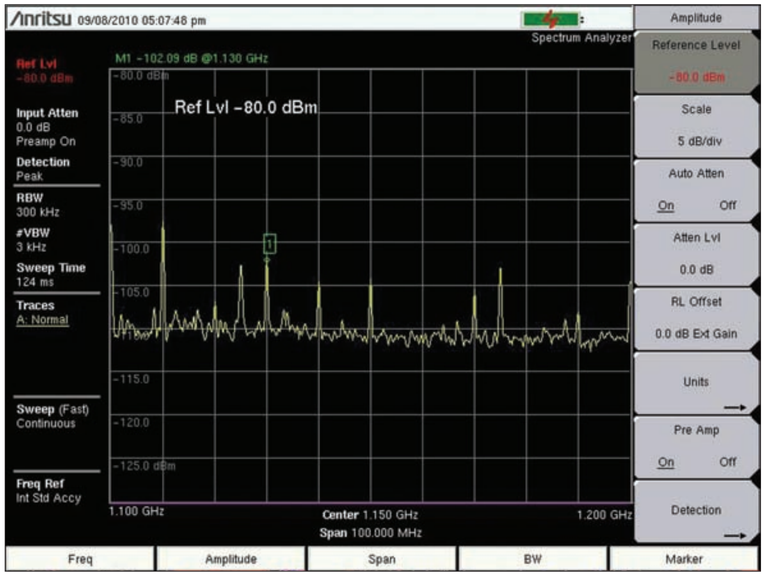

*Figure 14. Use smaller scale such as 5 dB/division to spread out the signals vertically*

If you want to strength the signal out even more you can Use the volts or Watts linear display choices to make small variations stand out more.

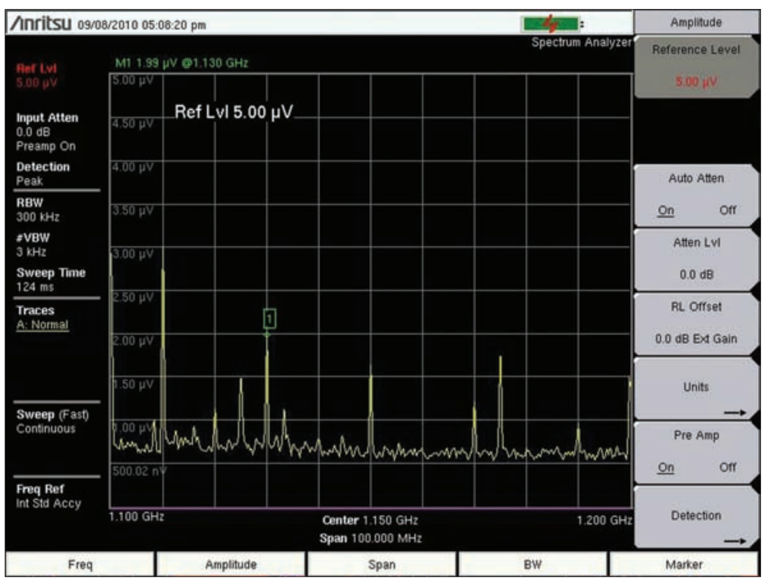

*Figure 15. Using a linear scale such as volts or watts per division can be used to make smaller signals pop out of the noise more.*

With the tips given in this application note, you will be able to make more effective use of the capabilities built into your Anritsu handheld spectrum analyzer to do spectrum surveys and find signals that may difficult to see otherwise.

Call for GSA quote and product information

**1-888-665-2765 or www.anritsu.gsamart.com**



Application Note No. 11410-00590, Rev. A Printed in United States 2010-10