Application Note

Spectrum Monitoring Techniques

Using a spectrum analyzer for unattended spectrum monitoring

Introduction

Spectrum monitoring is a powerful tool that can be used to ensure that the RF communications we all depend on for both civilian and defense applications work, and work well.

The need to make more effective use of our RF spectrum comes from a number of fronts.

- On the consumer side, as the move to smart phones and 4G/5G shows, the public appetite for bandwidth is growing rapidly. This is driving the re-farming of spectrum in auctions, spectrum clearing activity, coverage checks, and inevitably, activity by the broadcasters, who are giving up some of this spectrum.
- Emergency services are expanding into new bands with new technologies – P25, new versions of TETRA, or moving to LTE. This migration drives spectrum monitoring needs similar to the cellular needs, even if on a smaller scale.
- Defense departments around the world are becoming more and more dependent on electronic communications – for routine messaging, tactical communications, and covert operations.

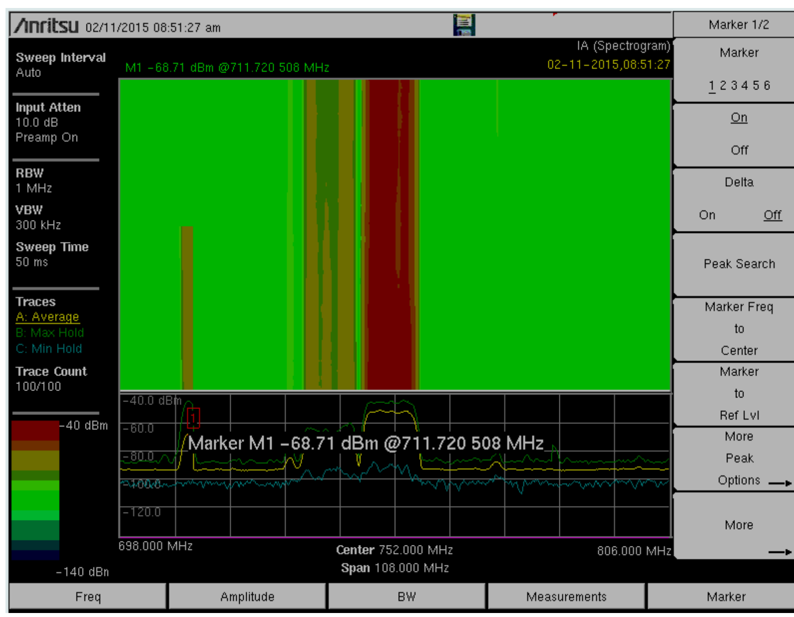

Figure 1: U. S. 700 MHz band showing new uplink activity at 712 MHz.

In each area, spectrum monitoring is used to ensure reliable communications. The need for effective spectrum monitoring will only grow for the foreseeable future. This note will help you understand the tradeoffs in monitoring spectrum, as well as how to set up your analyzer for your situation.

Contents

Why Monitor Spectra?

Spectrum monitoring is often used as the first part of an interference hunting process. However, spectrum monitoring can also be used to determine spectrum availability, characterize emissions, analyze transmission patterns, continually ensure that critical frequency bands are clear, detect illicit transmissions, and manage assigned spectrum. This paper will focus on spectrum monitoring techniques that can be used for all of these application areas. For more information on the complete interference hunting process, please refer to the Anritsu "RF Interference Hunting Techniques" application note, available on the Anritsu web site.

Significant work has been put into making communications networks robust. If the communications channel does not have the best signal-to-noise ratio, then modern digital communications networks add redundancy to the data. This makes the payload and its wrapper larger, taking up more bandwidth, and lowering system capacity. If your goal is coverage, a poor signal-to-noise ratio can be tolerated. But if the goal is to achieve the best capacity for your network, any spectrum issues causing an unnecessarily low signal-to-interference-and-noise (SINR) ratio needs to be addressed. The current move towards small cells, as well as the interference and cell edge issues inherent in LTE, only increases the need for a clean spectrum.

Figure 2: Cellular capacity is becoming important in many areas.

One network executive compared coverage and capacity with the analogy of a lake. If you have a large lake that's one foot deep, you have coverage. If you have a large lake that's 20 feet deep, you have capacity. A periodic or continuous spectrum monitoring program will allow identification and removal of interfering signals that reduce the capacity of digital communications. Increasing capacity of digital communications is one benefit of spectrum monitoring, which can also help you to better understand how your spectrum is being interfered with.

Spectrum Monitoring Techniques

Observe

The most basic spectrum monitoring technique is to go to the desired site, set up a spectrum analyzer, and observe the desired part of the RF spectrum. Simple in concept, this allows you to interactively manipulate the spectrum analyzer setup for the best results. When dealing with a communications antenna on a tower, it is common to use a receive test port from the tower top antenna to route the signal that the tower top antenna sees to the spectrum analyzer, because the RF signal at a height above ground is normally different than the signal at ground level.

Typically, if the task is interference hunting, and the interfering signal is present, the receive test port signal is characterized at this time. This allows the interfering signal to be readily recognized when the switch is made to a ground based antenna.

Record and Examine

Cases exist, however, there are cases where the interfering signal is not present when you are at the site. Also, many spectrum monitoring tasks require more than simply observing the signal visually. This is when recording the signal for later analysis becomes important.

One goal is to examine signals for bandwidth, shape, and spectrum usage. This may be to understand current spectral usage patterns or to look for signals that do not belong in this spectrum. Another use case is to record spectra for some future need. Regulators may do this so that if a spectrum usage issue comes up, they have a historical record to examine.

Record and Compare

Another common spectrum monitoring technique is to record spectra at one time, and compare that to spectra captured at a later time. This technique may be used to identify new signals or to spot signals that are no longer present. Use of trace math can make any changes stand out.

Each of these monitoring techniques has its own set of advantages, disadvantages and techniques. This application note will give practical guidance on making the best use of your Anritsu handheld spectrum analyzers for each of these monitoring goals.

Signals of Interest

A lot of signals are out there. Knowing what is normal and what is exceptional is a key skill of an engineer engaged in spectrum monitoring. Signals of interest include:

- Accidental interference
- Intentional interference
- Illicit signals
- Baselines

A wide variety of interesting signals are out there. Let's take a look at some of them.

Accidental Interference

Electronics tend to fail. Cable TV systems leak. Repeaters oscillate. Stop light controllers, RF TV remotes, and garage door openers fail. These are just a few examples of devices that have shut down licensed RF communications at one time or another. Cell phones can be a particular problem, because current cellular technology can be blocked by an individual cell phone that gets locked into full power mode. Fortunately, cell phone battery life tends to make this a short term event. Arc welders generate a wide range of RF interference, mostly below 400 MHz or so, as do industrial bakeries, with their large ovens.

Over-coverage is a uniquely cellular issue. Antenna mounting height, antenna elevation and azimuth adjustment, power levels, or even the presence of large bodies of water can all affect the coverage area.

Passive intermodulation, which is possible whenever two strong signals exist with some form of diode, is a long standing issue with RF systems. With the proliferation of new carriers and standards, PIM (Passive Intermodulation) testing has become necessary in much of the world.

Finally, harmonic distortion, often caused by faulty power amplifiers, can broadcast a comb of signals over large portions of the RF spectrum.

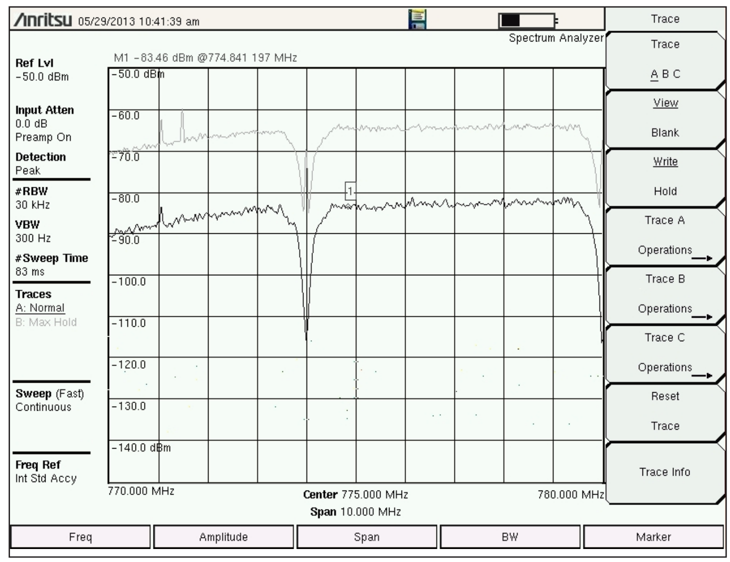

Figure 3: Cable TV leakage is easily identified by periodic "flat top" channels, spaced at the frequency plan for your country, such as 6 MHz in the US.

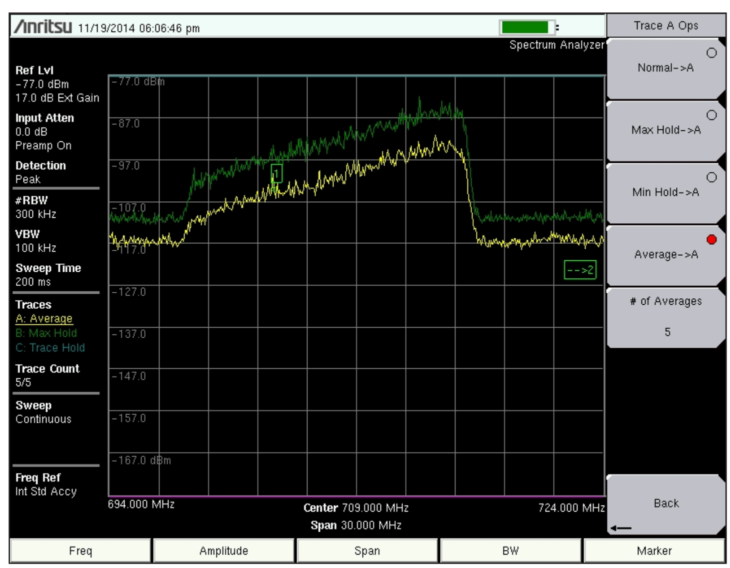

Figure 4: PIM can cause interference on cellular uplinks, even from a single carrier

Intentional Interference

Despite being illegal in many parts of the world, a thriving business exists for selling cell phone or GPS jammers. These very effective devices can be used to prevent students cheating on tests, stop employees taking phone calls on company time, or prevent your boss from tracking your travels. All of these activities risk heavy fines, because they may interfere with both emergency services and air-born navigation. Dealing with this sort of intentional interference is a very high priority.

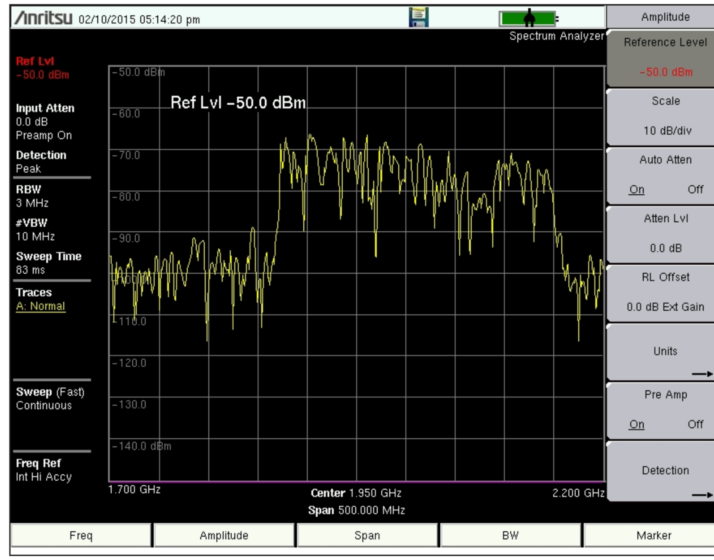

Figure 5: Jammers usually have a broad, noisy spectrum, such as this.

Illicit Signals

Some people just want to talk. Such things as over-powered CB radios or pirate FM broadcast stations attract the attention of regulators. Other things such as spoofing base stations, excessive radiated emissions from digital devices, and base stations transmitting on the wrong frequency cause problems with cellular networks. European phone systems in the Americas, or American based phone systems in Europe both tend to cause havoc, because when these systems are in the wrong region, they transmit on the same bands everyone else is using for reception. Another type of illicit signal is the miniature transmitter more commonly known as a bug. Quite a lot of activity exists in technical surveillance and counter-measures that relies on spectrum monitoring.

Baselines

Regulators or agencies in the defense sector often need baseline information on the RF spectrum. This is used to see what has changed since the last time they monitored the spectrum. A good baseline will show RF activity by frequency, shape, and time-of-day. It will allow the possibility of comparing today's spectrum to last week's or last month's spectrum. This is useful to see new signals that may be linked to an interference issue or signals that have gone off-the-air. It is also useful to understand how efficiently existing spectra are being used.

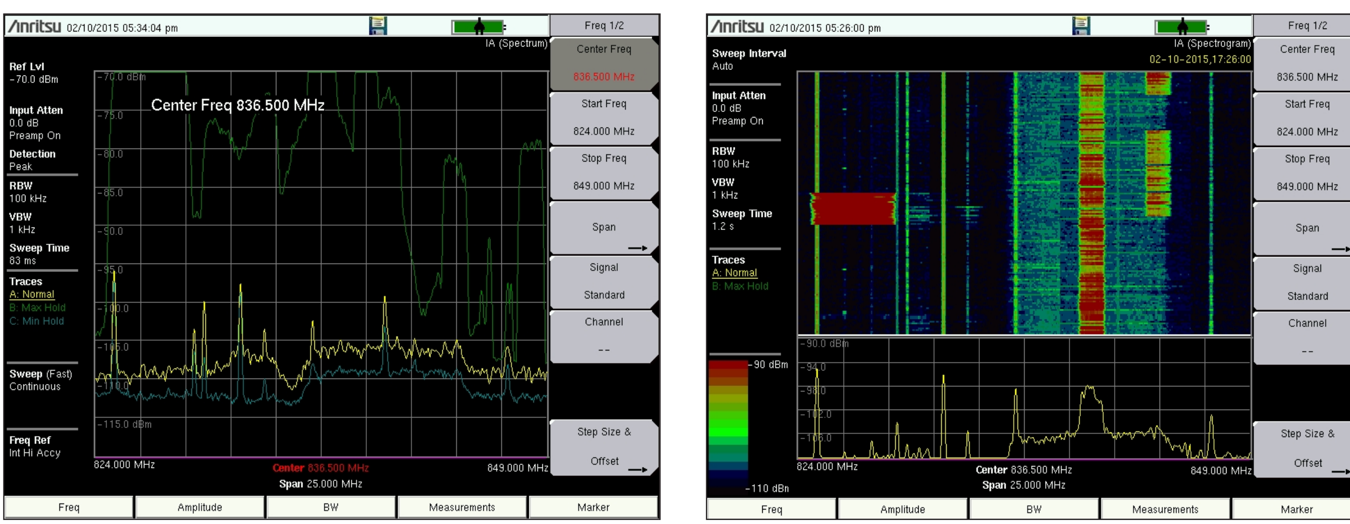

Figure 6: Max and Min hold traces can quickly show the range of amplitudes when taking a baseline, while a spectrogram highlights activity and inactivity.

Setting up to Monitor Spectrum

You may be observing a spectrum at a site, recording information for later analysis, comparing spectrum over time, or even observing spectrum remotely over an Ethernet link, but fundamental trade-offs exist when setting up a spectrum analyzer for monitoring. Setting up a spectrum analyzer while you are looking at the signal of interest is relatively simple, because you can correct for any error conditions as you watch the signal. Overload conditions, out-of-span conditions, insufficient resolution, or a slow trace update rate all can be dealt with when observing a live signal, whether you are at the site in person or accessing the instrument through an Ethernet link. However, when you need to set up an instrument for an extended period of unattended data collection, the setup questions assume a greater importance.

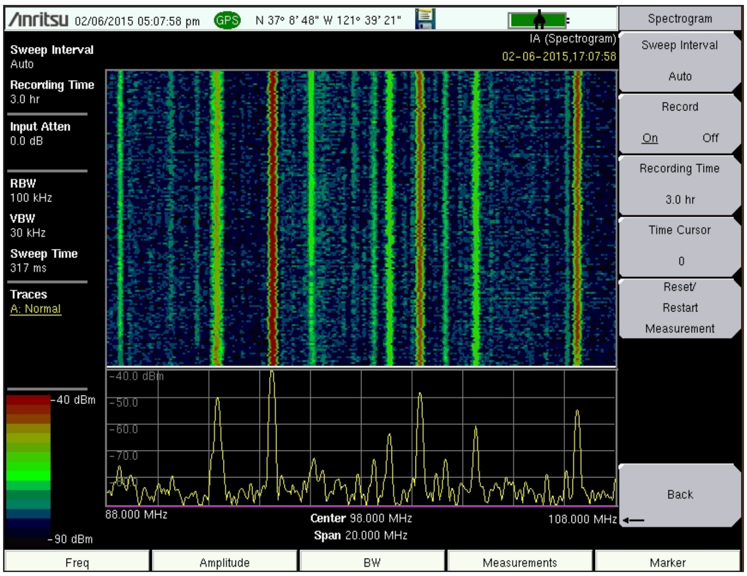

Figure 7: Spectrogram of FM broadcast band, showing many carriers.

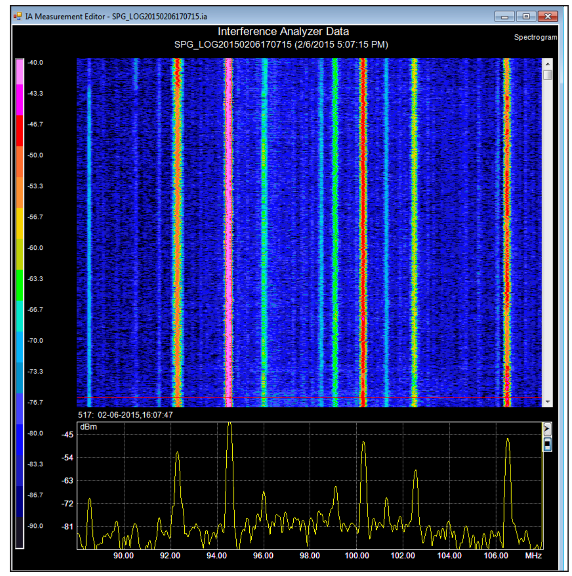

Figure 8: High-resolution spectrogram viewing using Master Software Tools (MST)

Selecting a Frequency to Monitor

Often, spectrum monitoring is done for the purpose of detecting and characterizing interference. It is important to know that receivers, not transmitters, are subject to interference. It is necessary to be looking at the frequencies used by the receiver, or in cellular terms, the uplink frequency. Also, interfering signals do not need to be on your receive channel to cause trouble. As long as they are within the bandwidth of the receiver front-end, they can de-sensitize the receiver or even block the signal. A thorough description of this mechanism and its effects can be found in the Anritsu application note “RF Interference Hunting Techniques” available on the Anritsu web site.

When spectrum monitoring is for enforcement, frequency clearing, or spectrum utilization surveys, the selection of frequencies to monitor becomes simpler, because it is part of the task definition. Part of that definition is ensuring that you have enough frequency resolution for what you need to know.

Selecting a Span and Choosing the RBW

This simple task gets a bit more complicated when you are setting up the spectrum analyzer for unattended signal monitoring, because you need to plan the settings in advance.

The first thing to know is that a spectrum analyzer may not be showing the true shape of the signal, but rather the shape of the instrument's resolution bandwidth (RBW) filter. That is the difference between the two narrow signals and the wide signal in Figure 9. The two narrow signals show the Gaussian response characteristic of a spectrum analyzer's Resolution Bandwidth filter. The wider signal is starting to show its true shape. A narrower RBW, or if in coupled mode a narrower span, will produce finer frequency resolution. For the remainder of this discussion, we will assume that the RBW is coupled to the span, so both change together.

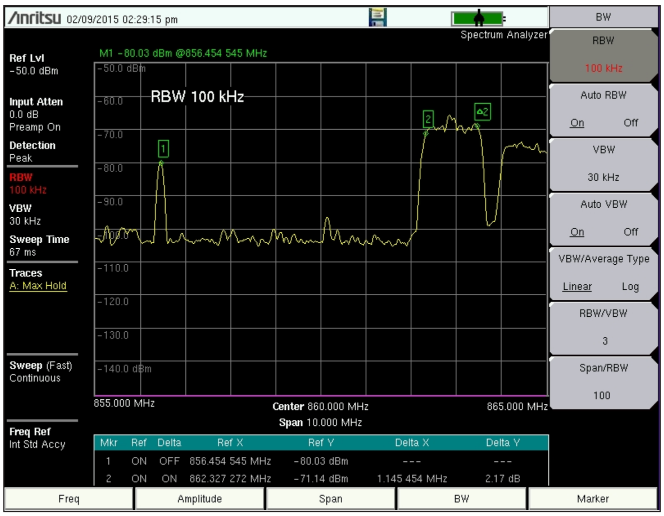

Figure 9: Spectrum trace showing both true signal shape (between the 2 and delta 2 markers) and two narrow signals showing only the spectrum analyzer filter shape.

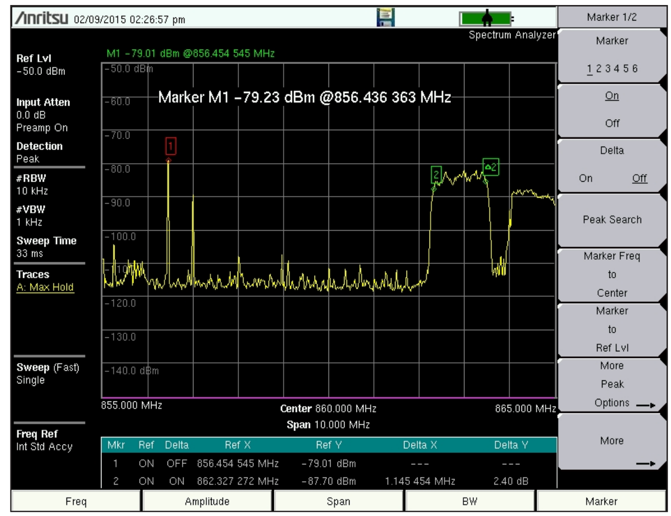

Figure 10: Same spectrum as figure 9, but with narrower RBW. Note some signals appear and disappear randomly in this frequency range.

A second consideration is that for many narrow band signals, the noise floor will go down as the span goes down, increasing sensitivity. This allows you to spot weaker signals if needed. Typically, the noise floor goes down 10 dB for every power of 10 reduction of the RBW. The trade-off is that a lower RBW implies a lower trace update rate, making the selection of a frequency band for monitoring more critical. Also, with a small RBW, it is harder to see signals that are changing quickly. Narrow RBW does not help for wideband modulated signals where the RBW is less than the signal bandwidth.

When in coupled mode, both small spans (e.g., <1 kHz) and large spans (e.g., multiple GHz) normally produce a slow trace update rate. Often, the sweet spot is a mid-size span that allows you to see the frequencies you really need to see, have a good trace update rate, and get an idea of the signal shape you are dealing with. A mid-span is also the best starting point for viewing a signal that is rapidly changing. It is possible to get sweep times of approximately 100 mS in spans between 100 kHz and 1.5 GHz.

Finally, while RBW normally is coupled to the span, it can be manipulated independently. However, if the span and RBW are manipulated to produce a fast sweep with a narrow RBW, amplitude accuracy will suffer. The RBW filter has a "Q" factor that sets its charging time. The narrower the RBW filter, the longer it takes to show the correct amplitude of a changing signal. That is one reason that RBW and span are coupled by default. Figure 11 summarizes the span selection trade-offs.

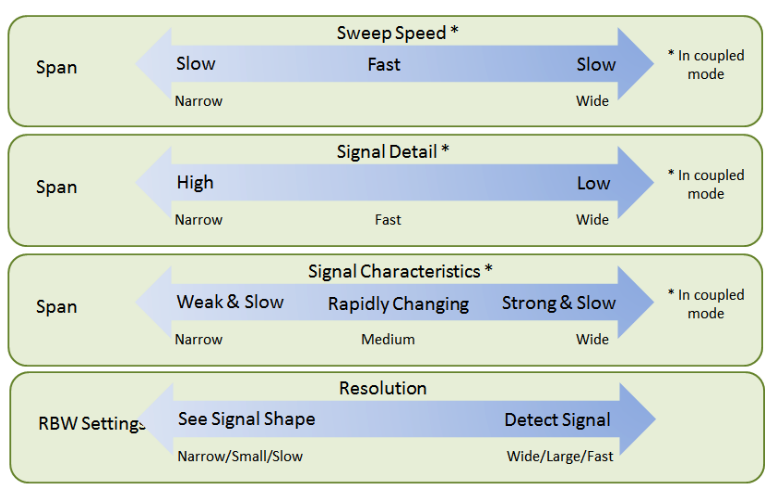

Figure 11: Span and RBW Trade-Offs: Wide spans work for strong signal spotting. Narrow spans work for weak signals. A medium span often works better than either extreme.

Sometimes the best set of tradeoffs is to take more than one visit to the site for data collection. This allows you to see what was collected the first time, and to adjust the spectrum analyzer settings based on that information for the second pass. Of course, if you have an Ethernet or 4G link of some kind, and are controlling the instrument remotely, this whole cycle gets much faster.

But if we are working with a Record and Examine or Record and Compare task, there are more ways to make the task easier. Spectrum analyzers have a selection of trace modes, detectors, and sweep modes just for this purpose. That is the next set of topics.

Trace Modes

Given the inherent limits on trace update rates based on RBW and Span (see above), how do we deal with signals that are not constant?

Setting the spectrum analyzer trace type is the first approach. Available trace types often include Normal, Max-Hold, Min-Hold, and Average. The last three trace types build up a record over time, and summarize the results in the viewed trace. Figure 12 illustrates some of these modes with a bursty Wi-Fi signal.

- Normal traces (illustrated in yellow) show what is coming in, as it happens. If the signal changes during the sweep, the trace level changes. That's why the yellow trace in Figure 12 goes up sharply just to the right of mid-screen. The Wi-Fi signal turned on while the sweep was in that position.
- Max-Hold trace (illustrated in green) does just that—holds the maximum amplitude for each trace point from multiple sweeps. This makes the trace continue to go up as various signals come and go. If a signal shows up once, it is recorded on the Max-Hold trace. Think of Max-Hold as a memory of the highest signal. Setting trace A to normal, and trace B to Max-Hold is useful in a number of situations, as it shows both the current power level and the excursion limits. That is part of what was done for the Wi-Fi signal in figure 12.

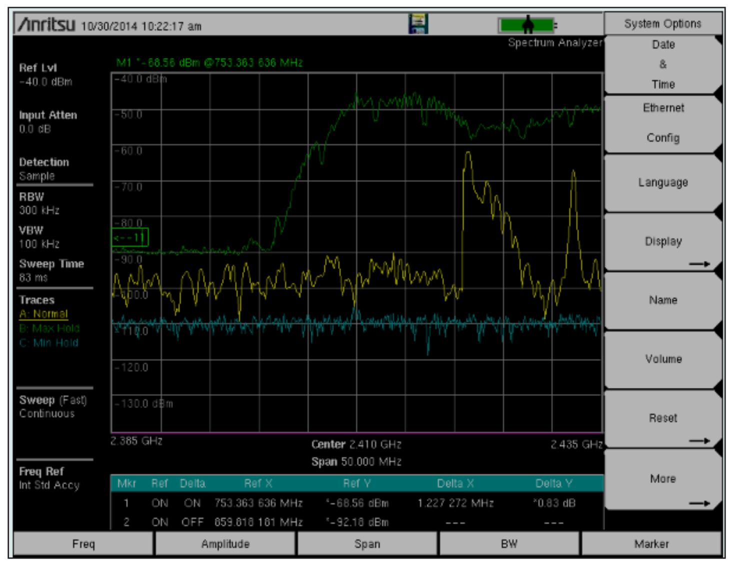

Figure 12: Quickly changing normal trace in yellow, a Max-hold trace in green, and a Min-Hold trace in blue.

- Min-Hold traces (illustrated in blue) are useful to see if a constant signal is hidden within a bursty signal. To take our Wi-Fi example, the Wi-Fi signal normally comes and goes. If there is a signal always present when the bursty signal is absent, Min-Hold will spot it. That is why the blue trace in figure 12 shows a small constant signal at the center of the screen.
- Average traces are the result of averaging a number of traces, with the number selected by the user. Average is a good, but slow, tool to remove random noise and highlight constant signals. It is great when the signal you are interested in is near the noise floor of the instrument.
- Trace Math can help highlight differences between the spectra at different points in time.

An alternative to trace averaging is to reduce the Video Bandwidth (VBW), which reduces the faster noise on the display without affecting the noise-like digital modulations, and does this much faster than trace averaging. This is an effective technique to reduce the "grass" on the trace noise floor. However, reducing VBW will also reduce signals that normally change very rapidly. It is a good "try to see if it helps" sort of control.

Detectors

Spectrum analyzers normally sample many more data points than they can display on the screen - tens, hundreds, or thousands of times more. This implies that the displayed trace needs to be summarized in some manner to choose the value to be displayed on each pixel of the screen.

This is done by the detectors. Detection modes include:

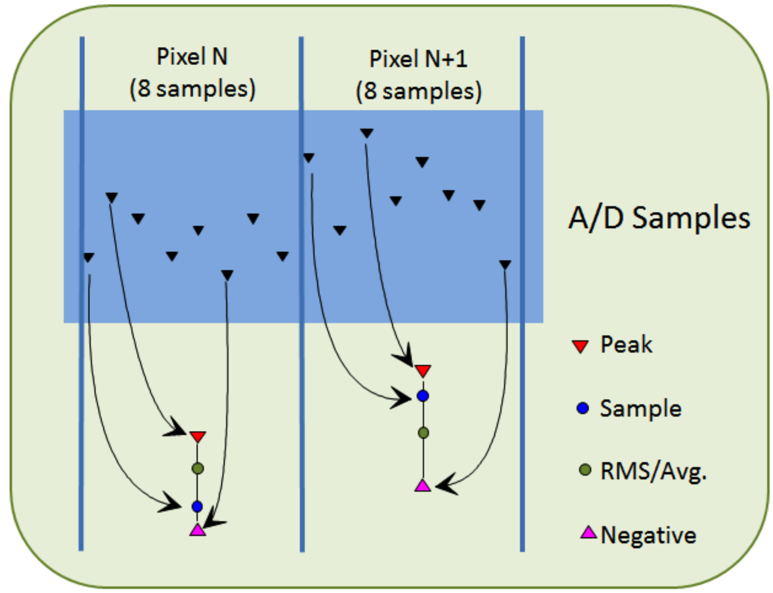

Figure 13: Four Detection Types

- *Peak* – This mode finds and displays the largest value in the target pixel. This detection method is a good complement to a Max-Hold trace. This is the default detector for Anritsu handheld spectrum analyzers, and a good choice for rapidly changing signals.
- *Sample* – This legacy mode selects an unspecified data sample to display in the target pixel. This will yield similar marker power measurements to the older analog spectrum analyzers. This is required by some standards but is not so useful for spectrum monitoring.
- *RMS/Avg.* – This mode averages the data points allocated to each pixel and presents the average value to the target pixel. This is a great detection mode to use if you are doing marker power measurements, particularly on the digitally modulated signals, because quite a bit of averaging happens in the detector, for each trace, before you even consider trace averaging or the VBW settings.
- *Negative* – This selects the lowest data point to display in the target pixel. Think of this detection mode as a supercharged Min-Hold.
- *Quasi-Peak* – this is a detection mode designed to mimic a quasi-peak power meter used for a specific EMC measurement. It is not normally used for spectrum monitoring.

For spectrum monitoring purposes, peak and negative can be quite useful, increasing the effective trace update rate by a factor of 2, 10, 100 or more, as compared with the trace modes of Max-Hold or Min-Hold. Detectors can be selected independently of the trace modes or in combination with them for a stronger effect.

Video Bandwidth (VBW)

The analyzer VBW filter helps smooth out noise variations in a trace, similar to the Average trace mode. However, the VBW filter has 2 advantages over trace averaging.

Because it works before the detection function, when used in combination with the peak detector, using a somewhat narrow VBW can reduce the apparent noise level on the display. This effect increases as the Span/RBW and RBW/VBW ratios both get larger. Improvements in noise floor of up to approximately 8 dB are possible in extreme cases by using narrower VBW, at the expense of a slower sweep speed. For moderate use of VBW, you can get 3-5 dB better noise floor when using the Peak detector.

Using the VBW/Average Type set to Log instead of Linear can also reduce the noise floor by up to 2.5 dB, without affecting the amplitude of CW signals. However, modulated signals can be reduced by as much or more, so this is only helpful when looking for low-level CW signals, or where the RBW is wider than the modulation bandwidth of the signal you are looking for.

In Anritsu handheld spectrum analyzers, the VBW function is also substantially faster than trace averaging. VBW can be hundreds of times faster in extreme cases.

Sweep Modes

Anritsu handheld spectrum analyzers have four sweep modes: Fast, Performance, No FFT, and (in the T series) Burst Detect mode. Performance has the best amplitude accuracy, while No FFT is useful for low spurious and good frequency accuracy. However, when thinking about update rates for spectrum monitoring, Fast Mode is the king of the conventional swept modes, while Burst Mode goes to another level entirely.

Fast Mode has a unique combination of the fastest sweep speed, so you can best deal with changing signal and good dynamic range, which helps you see small signals in the presence of large ones. Both of these attributes are useful when dealing with unknown signals. The trade-off is that Fast Mode has limitations in amplitude accuracy compared to the other modes. Sub-dBm amplitude accuracy is generally not needed when monitoring signals through an antenna, because RF path loss tends to be the biggest variable. For general purpose signal monitoring, Fast Mode is the way to go.

Burst Detect mode is uniquely qualified to be used with rapidly changing signals. You can think of it as a receiver mode for a spectrum analyzer. Tuning is fixed, and the rest of the IF chain deals with the signal as fast as possible.

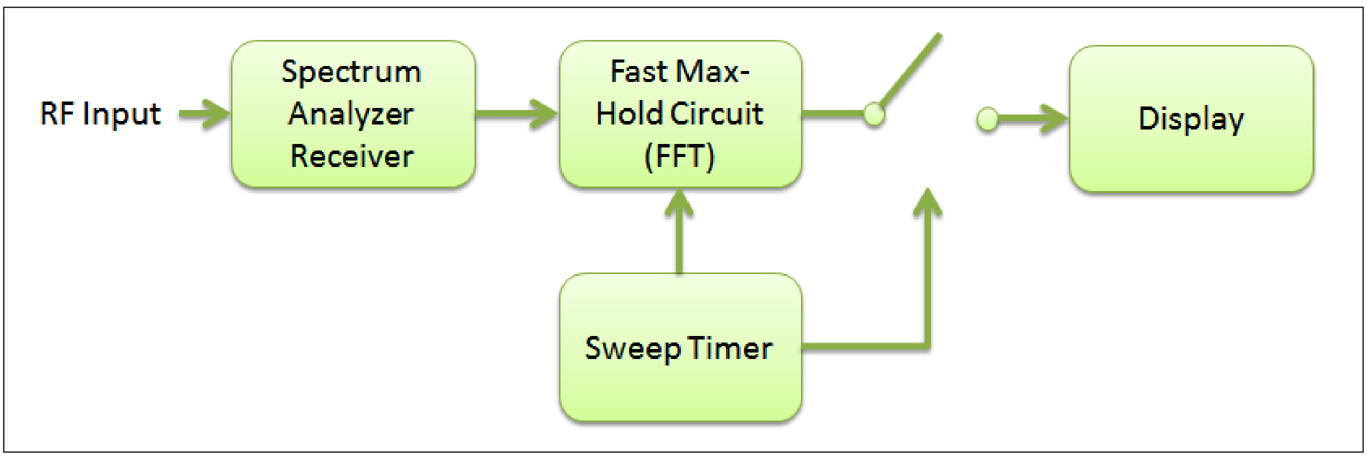

Figure 14: Burst Mode block diagram

Burst Mode works like a very fast Max-Hold. You can accurately think of it as assembling thousands of traces into a Max-Hold trace, but doing this work up to eight times per second. The work is done by dedicated hardware located in the Digital Signal Processing (DSP) part of the instrument. This hardware takes as many as 20,000 traces per second and guarantees capture of signals as short as 200 µs. If you use a Max-Hold trace in combination with Burst mode, burst capture is further enhanced. The effect on a bursty signal, such as many cellular uplinks or Wi-Fi, almost has to be seen to be believed. Do a web search for “Anritsu TV Burst Detect” for a video example.

Figure 15 again shows the a Wi-Fi signal, but now with Burst Detect mode selected. The yellow trace is active, the green trace is on Max-Hold, and the blue trace is set to Min-Hold. You can see from the height of the Min-Hold trace that the active trace captures the Wi-Fi burst each and every sweep. Compare this to the earlier Wi-Fi sweep in figure 12, which was taken in Fast Mode.

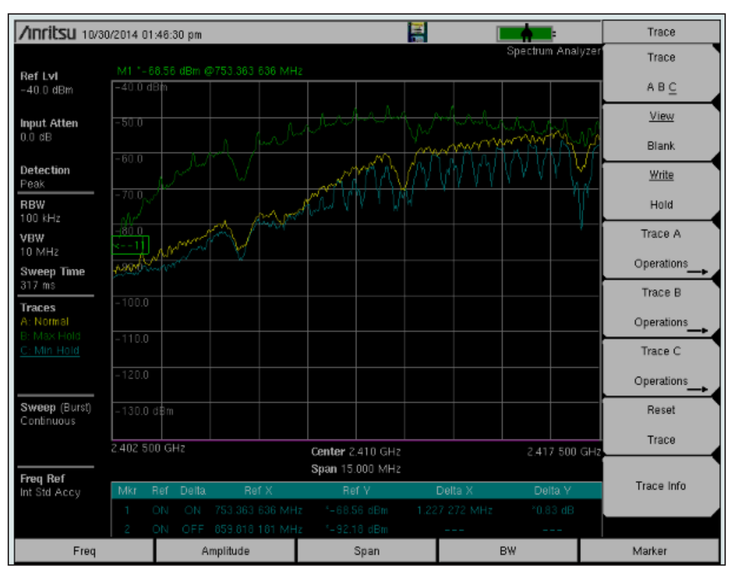

Figure 15: Burst Detect on a Wi-Fi signal.

Burst Mode is ideal for direction finding on common bursty digital signals, since it eliminates the need to wait for a Max-Hold trace to build up, and the need to manually reset the Max-Hold trace. In the commercial communications world, Wi-Fi, Bluetooth, GSM, cdma2000 uplink, 1x EV-DO, WCDMA Uplink, and the time division duplex signals all send bursty transmissions. Other common sources of bursty signals include radar, arcing (such as a welder might produce), and the micro-arcing associated with PIM.

Burst Detect mode is many times faster than any conventional spectrum analyzer or receiver, but one of the trade-offs is that you cannot do any center frequency tuning during a sweep. Because of this, Burst Detect mode spans have an upper limit of 15 MHz, which corresponds to the instrument IF bandwidth. Often, this is sufficient for the task at hand.

Sweep Mode Summary

Fast Mode is the best all-around sweep mode for spectrum monitoring. Burst Detect Mode can be quite useful when dealing with bursty or pulsed signals. The other two modes are useful for lab and standards based applications. Specifically, Performance Mode is slower but has the best amplitude accuracy and least spurs, while No FFT Mode corresponds to an analog spectrum analyzer normal sweep mode and is required for certain standards based measurements.

Amplitude Trade-Offs

The most defining characteristic of spectrum monitoring is that you do not know just what sort of signal you are going to find. Spectrum analyzers have a large range over which they can take measurement at any given reference level setting, so the actual reference level setting is not that critical, but even so, it is possible to overload the front end of a spectrum analyzer. This creates a condition in which the displayed trace may include artifacts created inside the instrument. Avoiding overload, while retaining sensitivity to see the smallest signals, is the topic of this section.

How strong might these signals be? While most signals that you pick up over an antenna will not be that strong, some will. Typically, over-the-air RF signals are less than –30 dBm at the spectrum analyzer, assuming that your antenna is not unusually close to the source or has more than 10 dBi gain. Near field measurements are another matter, of course. Human exposure limits, which start in the region of 1 mW/cm2 (think of 0 dBm and a 1 square centimeter plate as an antenna), have a lot to do with this experience-driven figure.

Spectrum analyzers are, by their nature, wide band instruments. The front end of a spectrum analyzer cannot be restricted in frequency range because it may need to be used anywhere in its specified frequency range. However, this wide band nature has a side-effect when used for spectrum monitoring. In many cases, a signal anywhere in the frequency range of the instrument can cause front end saturation. Nearby, but out-of-span signals can also cause an IF over range. A good example of a saturation is looking for signals using a span from 800 to 900 MHz, when physically close to an FM Broadcast transmitter that is broadcasting at 100 MHz or so. In this case your spectrum analyzer's front end may experience overload conditions from the 100 MHz signal. In this case, the signal causing an overload will not show up in your sweep. However, on Anritsu handheld spectrum analyzers, a Saturation alarm will show up. This is an indication that the trace may include artifacts created by the large out-of-band signal. A similar situation can occur with somewhat lower-level signals that are just outside of the span, for example at 799 MHz for our span from 800 to 900 MHz. In this case the instrument gives an ADC Over Range alarm, and colors in red the part of the trace affected by the problem. Out-of-span signals overloading a spectrum analyzer's front end can be mitigated by:

1. Increasing Input Attenuation or Reference Level
2. Turning off the Preamp
3. Limiting the frequency response of the instrument with an external pre-filter
4. Changing the sweep mode or RBW setting
5. Selecting an antenna location or direction further from the signal that is causing the overload

Attenuation and Reference Level

Changing the Input Attenuation or the Reference Level is the first method to try. This can be as simple as raising the instrument's reference level. If the reference level needs to stay where it is because of the signals under observation, spectrum analyzers allow the input attenuation to be increased in small steps independently of the reference level. The tradeoff is that you will lose small signals in the noise floor as the attenuation is increased. This is why input attenuators are often made with fine steps of 5 dB or so. Increasing the input attenuation is the most common solution to input overloading. Increasing the Reference Level, even with the attenuation held constant, can also help by reducing the gain in the analog IF.

Preamp

Turning off the preamp is often helpful. A typical built-in preamp might reduce the analyzers noise floor by about 10 dB, so when you turn off the preamp you can expect to see the noise floor come up by that amount. This will reduce the signal at the input of the spectrum analyzer's first mixer and may take care of a saturation issue. On the other hand, this makes it difficult to view weaker signals.

Band-Limiting

If you have a Saturation problem caused by a large transmitter at a different frequency, and you have to add so much attenuation that the noise floor is too high, then the best tool to use is a filter. You can band-limit the input to a spectrum analyzer in many ways, including:

1. Band Switching. Many spectrum analyzers use a technique called band switching internally to deal with the very wide frequency range they cover. While band switching occurs transparently to the instrument user, you can take advantage of this if you know the instrument's bands. Large signals outside the current band are attenuated naturally inside the spectrum analyzer.
2. Most antennas have a passband, a range of frequencies for which they naturally work well. This means that they function somewhat like a band-pass filter, and reject signals outside of their band pass frequency. This effect can be used to advantage in many spectrum monitoring situations. Be careful though, as many antennas also work at harmonics of their pass band frequency.
3. Anritsu supplies sets of external pre-filters for just this situation. Available for most cellular bands, these lightweight filters can be inserted anywhere between the instrument and an antenna. It is important that the pre-filter be ahead of any active component, such as an external preamp, otherwise distortions can occur in the preamp. The MA2700A data sheet lists a set of filters designed for cellular operators, while the MS2720T data sheet lists filters designed for more generic situations such as public safety applications.

Figure 16: An in-line band-pass filter with the Anritsu MA2700A Handheld InterferenceHunter™ handle

Some engineers prefer receivers over spectrum analyzers for spectrum monitoring because of the spectrum analyzers' wide front end versus the band limited front end of a receiver. A narrow band receiver, dedicated to the band to be monitored, can indeed be fast and efficient, though some thought needs to be given to how to display the signal once captured. However, if the receiver is wide band, it runs into the same engineering issue as a spectrum analyzer. A wideband receiver has no inherent input protection. Even receivers that have built-in preselectors may be designed more for sensitivity than for dealing with large signals, or the bandwidth of the preselector may be too wide to help in many situations. See the topic on spectrum analyzer third-order intercept for more about this.

Sweep Mode & RBW

If all else fails, you can try reducing the RBW or changing the Sweep Mode to Performance. These may invoke a narrower filter bandwidth in the analyzers analog IF, which can help eliminate ADC Over Range problems. Often a better solution can be found by using filters, or a better choice of antenna.

Antenna Considerations

The receiving antenna location deserves consideration for spectrum monitoring. If you are physically near a large signal source, such as a Broadcast Radio transmitter, TV station, or a paging transmitter, it may be a good idea to find a different location. That will eliminate a lot of fiddling around with filters and attenuators. While the best dedicated monitoring posts are far away from transmitters, this is not normally possible, and we need to settle for "reasonably quiet." There are tradeoffs here, but for practical purposes, finding a location that is not susceptible to input overloads caused by out-of-span signals is normally sufficient.

But the topic of antenna location is bigger than just the RF environment. Other considerations include:

- If the task is to monitor for cellular uplink interference, using a receive test port for a sector antenna may be the best choice. This ensures that the spectrum analyzer will see the same signal the sector receiver sees. The antenna height, gain, pattern, and any filtering all are accounted for. This type of antenna, especially if there is a tower-mounted preamplifier, is often ideal for spectrum monitoring, because it is designed for the best practical sensitivity.

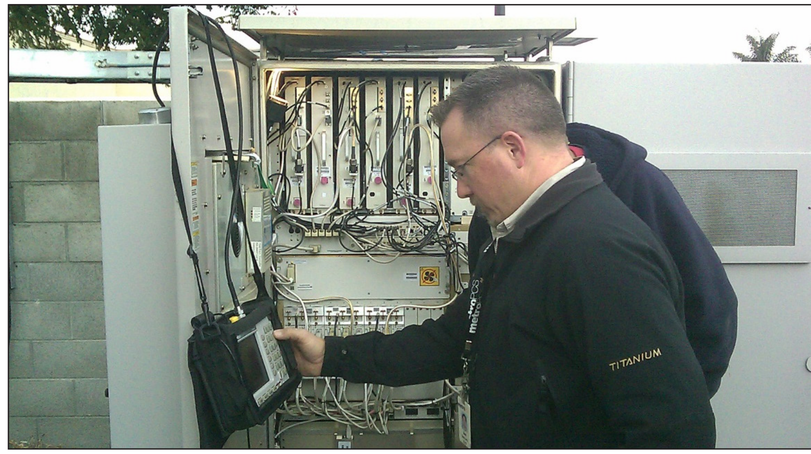

Figure 17: Monitoring a test port on a base station lets you see what the base station receiver is seeing.

- If the task is to record spectral data over a wide bandwidth and a wide area, a large steerable log-periodic antenna on a mast may be called for. This scenario requires careful selection of the monitoring site.
- If the task is to spot local reception interference, a secure place to leave the spectrum analyzer and a small antenna may be best.

For this case, some spectrum analyzer users prefer to use a short "rubber duck" antenna mounted directly on the spectrum analyzer's input jack. While this is convenient for handheld use, and definitely small and portable, the antenna reception strength will change as you move and tilt the spectrum analyzer due to the antenna pattern. While this effect is not strong given the low gain of most rubber duck antennas, it is something worth being aware of. Another consideration is that putting the antenna directly on the spectrum analyzer makes it probable that the antenna will pick up emissions from the instrument itself which will then be displayed as signals. If you use a rubber duck antenna attached to the instrument, please be aware that if you see a low level signal that does not change amplitude as you move around, it may be coming from your instrument! Keeping the monitoring antenna a few feet away from the spectrum analyzer will eliminate this concern.

Figure 18: Large Log Periodic antenna on a mast

Figure 19: The Anritsu MS2720T is a compact, battery powered instrument that can be left at a monitoring location. A Kensington lock slot is available for security purposes.

- For vehicle based applications, a magnetic clamp-on omni-directional antenna may be optimal. This allows mobile use and can be moved quickly from one vehicle to another. If field strength is an issue, a vehicle mounted mast, for use when stopped, can help standardize the measurements.
- For hand-held applications above 500 MHz, a Yagi is recommended. The Anritsu MA2700A is designed to make this task easier, because it incorporates a compass, a preamp, available pre-filters, and a GPS in a convenient handle that can also mount a Yagi antenna.
- For handheld applications below 500 MHz, a loop antenna, like the Anritsu 2000-1778-R or similar, works well. Some loop antennas have a sharp null in the plane of the loop that can be used for direction finding.

Figure 20: Magnet-mount antenna used for signal hunting

Figure 21: Yagi-antennas are often optimal for signal hunting on foot.

Figure 22: Loop-style antennas are often best for lower frequencies

Remote Operation – Looking Ahead

Much of the discussion has been on trade-offs when setting up a spectrum analyzer for unattended data collection. The uncertainty involved in setting up a spectrum analyzer to accurately measure an unknown set of signals is greatly reduced if you can interactively view and operate the spectrum analyzer from a distance. We will talk more about this later, but for now, know that if there is an Ethernet link available, Anritsu handheld spectrum analyzers can be operated remotely from a computer, smart phone, or tablet – anything with a current generation browser.

Trace Management Strategies

If you are working with an unattended spectrum monitoring situation, trace management is worth some thought. Saving one trace per second for a month can really add up. At an average trace size of 50 kB, you can expect to collect something more than 100 GB of traces, or 2,592,000 individual traces in a month. That is a lot of traces to store, a lot of time to move the traces, and an incredible amount of time to review the traces. There must be a better method. This section will consider how to collect traces in a way that is useful when the spectrum monitoring task is complete.

Time Resolution

How often traces are collected affects both the size of the resulting data archive and the time resolution of the resulting archive. Often, the initial idea is to collect traces as often as possible, so that you can spot short RF events. This leads directly to issues with data size and a massive trace reviewing task. However, the rate traces are collected does not need to affect the ability to detect quick RF events such as bursty transmission or EMI pulses. Spectrum analyzers have many ways to summarize quick RF events, reduce the file count, and make data analysis faster. That is what we will cover next.

Save-on-Event

Save-on-Event is a spectrum analyzer technique that can:

1. Save a trace at the end of every sweep
2. Save a trace when an event mask is violated.

While saving at the end of every trace can be useful, particularly if you don't know just what you are looking for, it also generates a lot of traces. Figure 23 shows a yellow normal trace and a green Max-Hold trace. The event mask (the green line with the circles) was generated from the Max-Hold, trace and an offset was added. Now, we have several choices:

- Save on Crossing Limit allows us to save traces only when the event mask is violated.
- Save then Stop allows collecting exactly one trace. This is useful if any mask crossing is significant enough to stop monitoring and go do something about it.
- Save on Sweep Complete will generate a saved sweep whenever a sweep is complete. This is the "Save Everything" option. On a mid-range span like this one, that can be a lot of sweeps!

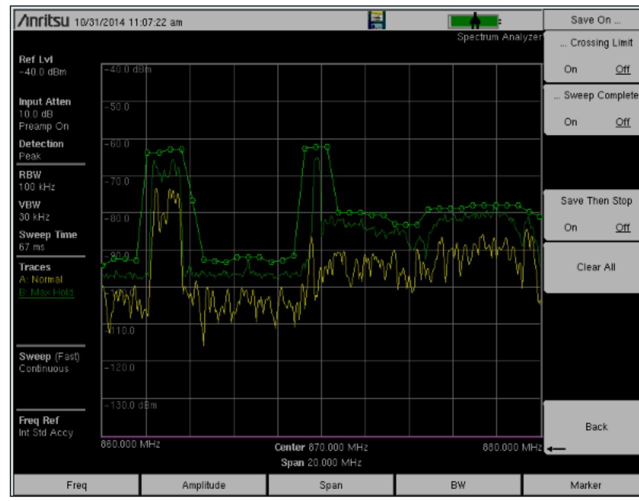

Figure 23: Save-on-Event with a trace mask.

So how do we view all those traces? Anritsu handheld spectrum analyzers have PC based software available to do just this task. Master Software Tools (MST) greatly simplifies the task of examining Save-on-Event sweeps. In this case, the instrument will save traces in sets of 100 traces per directory. It will automatically name the traces and also will automatically generate and name the directories. MST can take these traces, in these directory sets, and generate spectrograms from the traces. The functionality is called "Folder Spectrogram" and is available in any current version of MST. To find this in MST, press File -> New -> Folder Spectrogram. The result is shown in figure 24.

In figure 24, the display shows a Frequency versus Power plot on the bottom and the Spectrogram resulting from all the traces collected on top. As you scroll through the spectrogram, you can see the relevant Frequency versus Power plot on the bottom. This is a great way to look for anomalies in the RF signal. One Folder Spectrogram can display up to 15,001 Save-on-Event traces. This is over 4 hours of data at one trace per second, with no data reduction.

If you have more traces than that, you can view them in sets of 15,000. You might also consider reducing the number of traces you are recording, either by using Save on Limit Exceeded, or by increasing the sweep time. The latter works particularly well in combination with Burst Detect sweep mode and the Peak detector, because the instrument keeps track of the highest peaks during the sweep time. It is even possible to filter the files with a limit line in MST, but it is easier just to not record unnecessary traces in the first place, if possible.

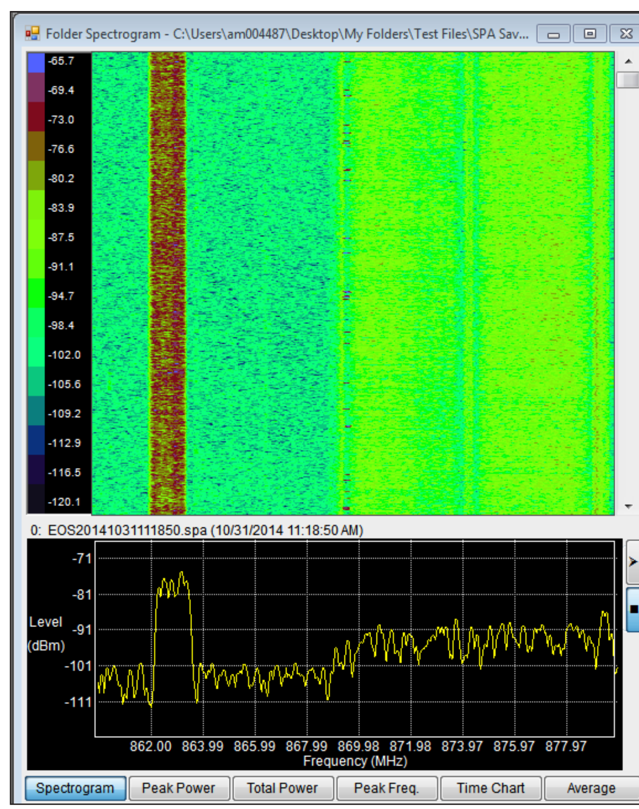

Figure 24: Save-on-Event traces displayed in a MST Folder Spectrogram display.

Save-on-Event Tradeoffs

Save-on-Event advantages include:

- Simple to use
- Has a GPS tag with location and UTC time with every trace, so it is suitable for a mobile recording application
- Can reduce data by using an event mask trigger.

Save-on-Event disadvantages include:

- Not the fastest update rate, because a save occurs after every trace capture.

The update rate, in this case, was approximately one trace per second. The actual sweep time was quite a bit faster, but a delay occurred between every trace to give the instrument time to save the trace. You have a faster way to do this.

Spectrogram Record Mode

Anritsu's handheld spectrum analyzers (with option 25) also allow you to record complete spectrograms, not just traces, over a period of time. This can be significantly faster than Save-on-Event because the number of files saved (a slow operation) is greatly reduced. Recording parameters include:

- Length of time for the recording
- Trace update rate
- Trace Mode
- Sweep Mode

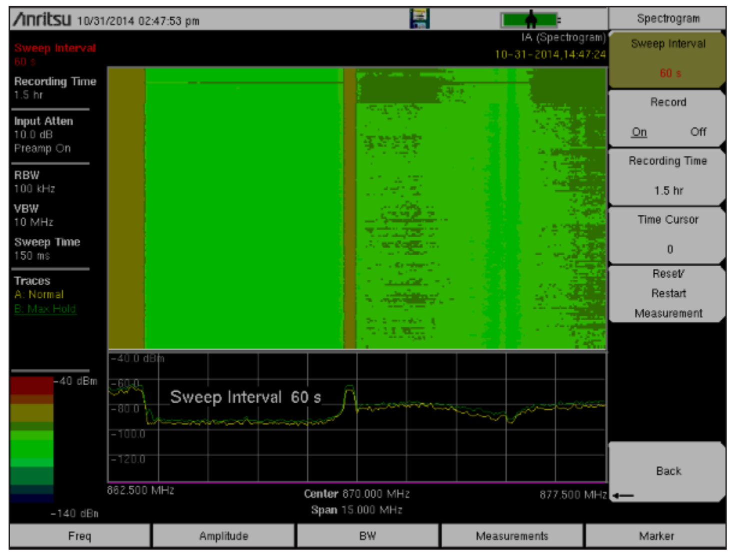

Figure 25: Spectrogram recording time setup.

Length of Time

The length of recoding time can be set in the Spectrogram menu. If the Sweep Interval is set to Auto, traces will be updated as fast as possible. But you can also specify that traces update more slowly, as shown in figure 25, where the trace update rate has been set to 60 seconds. In figure 25, trace B has been set to Max-hold, and the sweep mode has been set to Burst Detect. This setup has a number of advantages:

1. The sheer quantity of data to analyze is reduced by a factor of 60 or more.
2. The number of files to deal with has been greatly reduced, from hundreds or thousands to only a few, or perhaps tens of files.
3. Burst detection is superb, because it will rapidly detect pulses as short as 200 uS.

The trade-off is that time resolution has decreased to one update per minute. But since that also comes with the ability to detect very short pulses, that may be an acceptable trade-off. You can think of the trace update rate as a "What time of the day did this happen?" measurement, while the Max-Hold trace, and if you can use it, Burst Detect, give you the answers to the "Did anything happen?" and "What shape was it?" questions.

In this example, the trade-off is between using a wider span and Max-Hold or using a 15 MHz or narrower span and Burst Detect mode, particularly when using a timed spectrogram recording. If the span was wider so that Burst Mode could not be used, each saved spectrogram trace would be the max hold of everything that happened over the 60 second trace recording interval. In that case, what you would have is a spectrogram of max hold traces where each saved trace was a new Max-Hold trace capture. The Max Hold trace would build at the instrument's native trace rate, updating perhaps twice a second, but would record results and start a new Max-Hold trace once a minute. If you had a 15 MHz or narrower span, and used Burst Detect Mode, you would reliably detect pulses as short as 200 uS, still with a once-per-minute resolution.

The key point is that time resolution is not the same thing as the ability to detect short bursts of RF. The interval between recorded traces can be thought of as the "time of day" resolution, while the native trace update rate, whether in Burst mode or Max Hold, determines the minimum signal burst time that can be detected.

Spectrogram Recording Tradeoffs

Using a spectrogram recording for unattended monitoring has the following advantages:

- Fastest possible time resolution
- Simple to use
- Also has a GPS tag with location and UTC time with every trace
- Works well with Max-Hold and Burst Detect mode
  - – Can slow down acquisition to reduce the amount of data saved without missing quick signals.

Spectrogram Recording disadvantages include:

- Need option 25 on the instrument
- Cannot use limit lines to reduce data capture
- Limited to 3 days of recording time in one session

How to Set Up a Spectrogram Recording

It is fairly quick to set up a Spectrogram recoding. Here is how you do this:

- Using an Anritsu Spectrum Master with option 25, go to Interference Analyzer mode
- Select Measurement, Spectrogram
- Press the Spectrogram button again to enter the Spectrogram recording menu
- Sweep Interval is the time between collected traces. “Auto” is as fast as possible. Longer times enable the use of Max-Hold to summarize data. Any sweep interval works with Burst Detect mode, as long as the span is between 15 MHz and 20 kHz.
- After “Record” is enabled, the “Recording Time” button is displayed.
  - – If the recording time is longer than 156 traces, the instrument will save a series of spectrograms of 156 traces each. MST can stitch these together into one large spectrogram. If this creates more than 100 spectrograms, the instrument will create directories with 100 spectrograms in each one.
- The time cursor is a white horizontal line in the spectrogram. It is used for choosing the spectrogram that shows up in the lower Frequency versus Power window.
- Reset/Restart measurement restarts a timed recording.

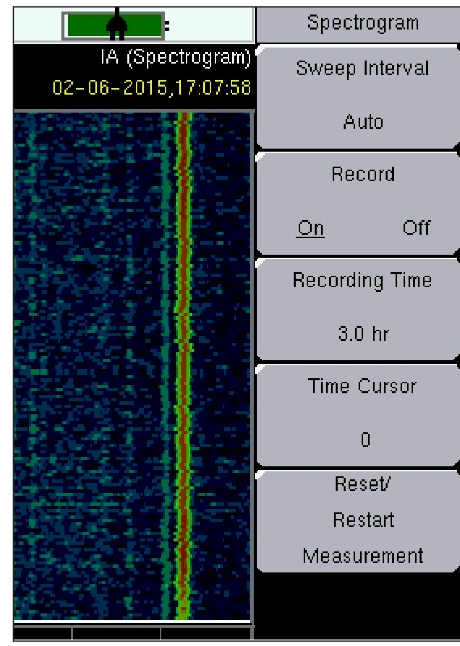

Figure 26: Spectrogram recording time setup.

In the example in figure 26, the instrument has been set up for a 60 second trace interval and a 1.5 hour recording time. The instrument is also in Burst Mode. If the span was wider than 15 MHz, a good choice would be to set trace A to Max Hold, which will reset between sweep intervals. All trace modes are supported for spectrograms, including trace math.

As mentioned above, Master Software Tools (MST) can stitch recorded spectrograms together into one large spectrogram. Figure 27 shows 100 individual spectrograms stitched together into one large spectrogram using Master Software Tools.

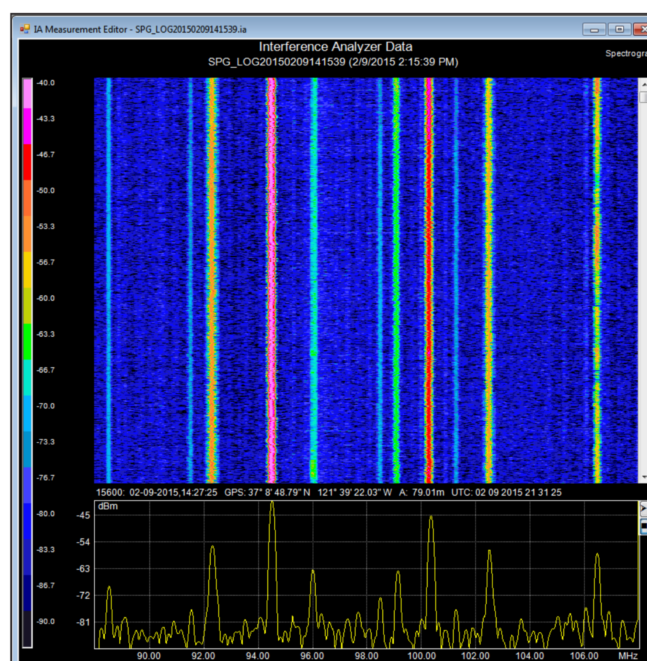

Figure 27: Long recorded spectrogram of the FM band displayed in Master Software Tools.

Expanding Spectrum Monitoring Capability

Channel Scanner

The channel scanner option to Anritsu handheld spectrum analyzers provides channel power readouts for up to 20 channels sequentially. The channel scanner is useful for measuring discontinuous channels such as can be found in public safety systems, white space monitoring, or telemetry. The channels can be selected from:

- A signal standard. In this case, you would select the channels of interest by channel number.
- A set of frequencies. In this case, you select a starting frequency, bandwidth, and frequency increment.
- A custom list of frequencies, as shown in figure 28. This allows you to take channel power measurements for a set of user defined channels. These channels may be scattered around the spectrum, and each one can be set to its own bandwidth.

Figure 28: The Channel Scanner in Frequency Scan mode.

- Finally, Master Software Tools has the capability to generate custom scan lists, allowing scripting of the channel scan capability.

The channel scanner reports true channel power (not just marker power) anywhere in the spectrum that monitoring is needed.

Zero Span Measurements

Zero span measurements can be useful when you need to identify the signal type. In Zero Span, the spectrum analyzer stops sweeping and becomes a fixed-frequency receiver. The display becomes a Power vs. Time display, as shown in figure 29, with a bandwidth set by the current RBW filter, and the center frequency set normally.

One useful Zero Span control is the sweep speed control. In this case, the sweep speed was set to 5 seconds (as shown on the display horizontal axis) to allow better viewing of the signal activity.

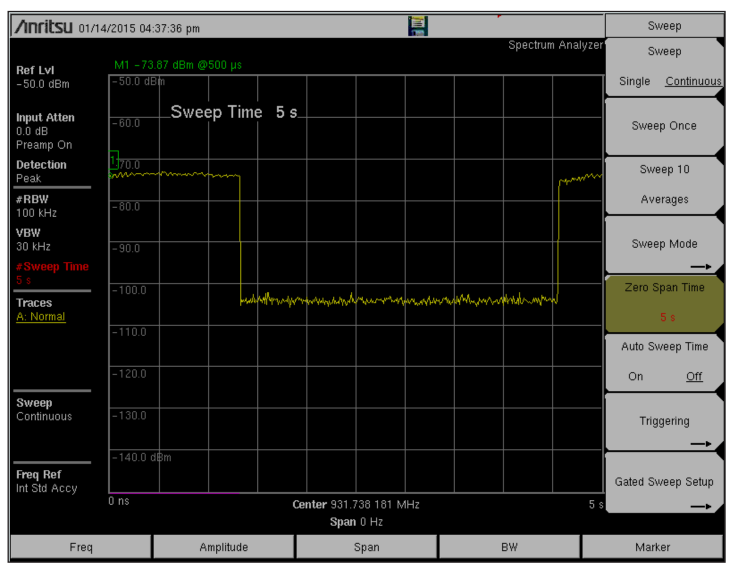

Figure 29: Zero Span display.

Zero-span has other uses as well, because it shows the signal timing, and if multiple sources exist, it shows the relative amplitudes. The zero-span trace of the ISM spectrum shows several different Wi-Fi signals and different amplitudes.

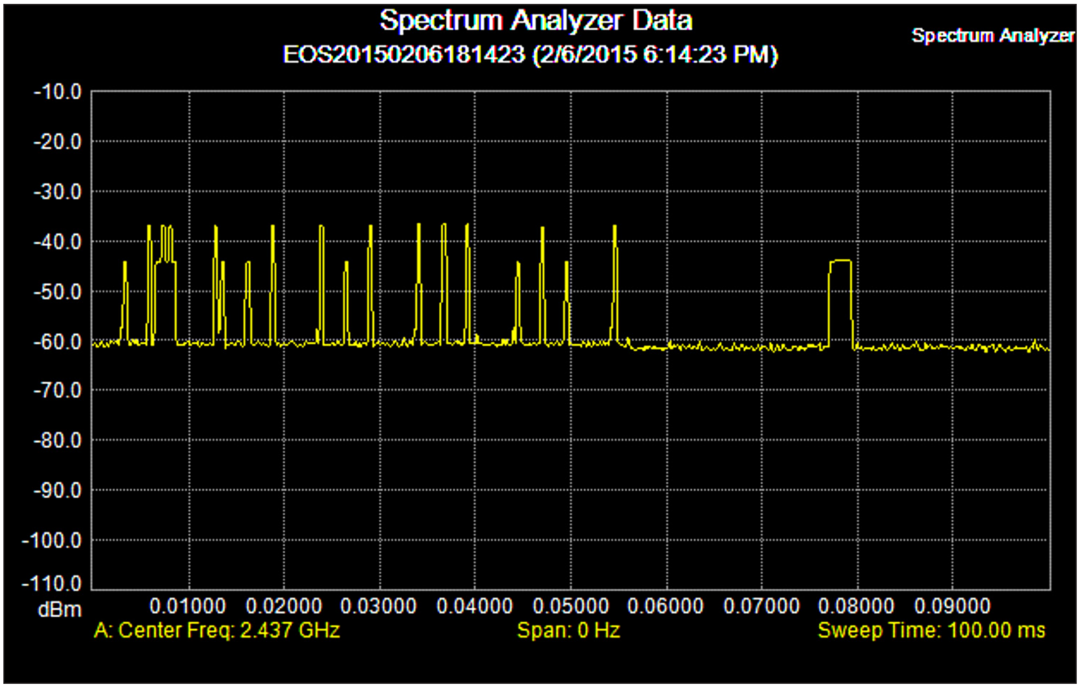

Figure 30: Zero-span trace of a Wi-Fi signal showing pulse timing and relative amplitudes.

Analog Signal Demodulation

Spectrum analyzers have long offered the ability to listen to analog signals, much like a shortwave radio would allow. In some cases, this may offer a fast way to identify the signal, for instance, if a station ID is given. While identifying broadcasters may seem straightforward, remember that you may be dealing with a harmonic of the fundamental signal, so you might be looking at a signal well outside of its assigned band. Other possibilities include intermodulation products that still may have an audible, intelligible content, and point-to-point radios used in commercial or public safety applications that are transmitting outside of their assigned frequencies. Also, paging transmitters and aeronautical navigation aids have Morse code station identification.

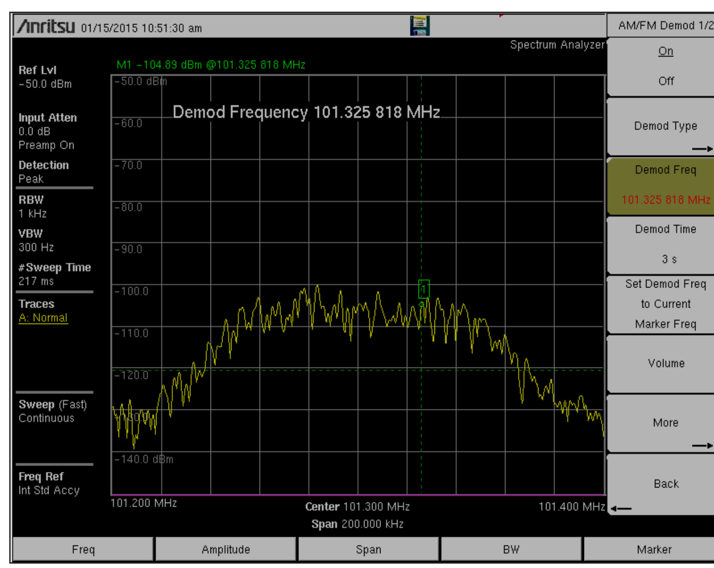

Figure 31: Analog signal demodulation

In the case of the Anritsu handheld spectrum analyzers, make sure that the signal of interest is on the screen. It is best if the span is adjusted so that the signal fills half the screen or more. Then go to the demod menu (Shift, Meas -> AM/FM Demod -> On) to get started. If you do not already know the demod type, try them all and see what works best. The “Demod Frequency” control sets the frequency that is being demodulated, while the “Set Demod Freq to Current marker Freq” button does just that, and also provides a visual verification of the exact signal that is being demodulated.

Spurious Emission Measurement

While the Spurious Emission measurement is intended to be used as part of standards-based transmitter test, a creative use of this measurement allows setting up a set of arbitrary spans and center frequencies for pass/fail testing. The figure to the right shows the results of a three segment Spurious Emission test with pass/fail testing. Results can be saved either to internal memory or to an external USB memory stick. This provides a similar functionality to the channel scanner, but can save trace data, not just power levels. It is slower than the channel scanner, though. The three sweeps shown took perhaps 65 seconds to complete. A similar set up with the channel scanner took only 2 seconds. The advantage for the Spurious Emission test is that waveforms can be captured, and pass/fail judgment can be implemented. Save-on-Event functionality is also available while performing the Spurious Emissions test, but Limits need to be created for all segments at once.

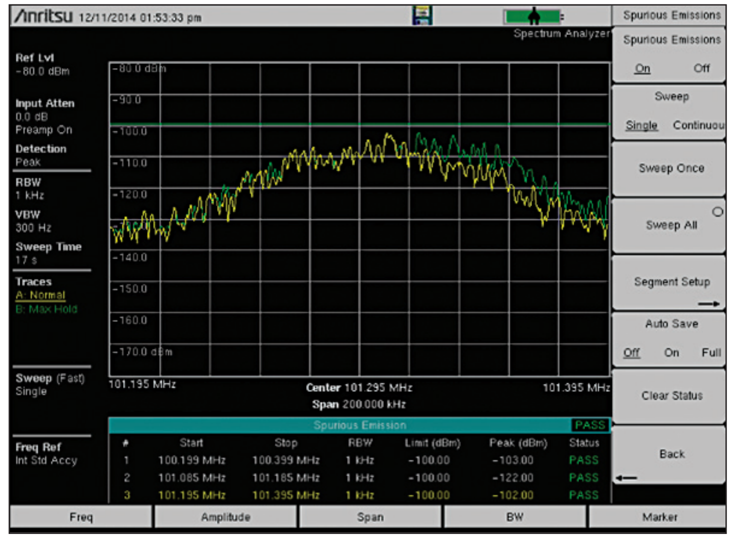

Figure 32: Spectrum view of FM band. Note the large number of low-level carriers. Limited display resolution makes it difficult to see details for this crowded spectrum.

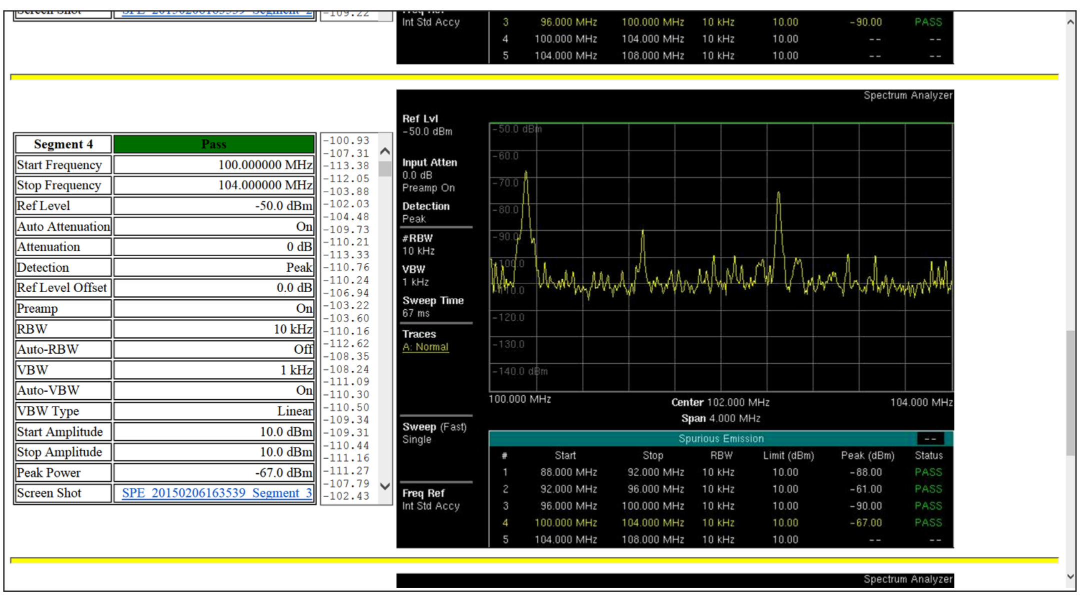

Figure 33: Segment 4 of a 5-segment spurious emissions test, again of the FM broadcast band. Note the improved frequency resolution available compared to the signal in figure 32 above display.

easyTest Tools

easyTest Tools is a PC application that creates scripts for the Anritsu spectrum analyzers. It is useful to be able to start fairly complex instrument operations when engaged in spectrum monitoring. easyTest works with four basic capabilities to keep the scripting simple. It can cause the instrument to:

- Recall a setup
- Display an image
- Display a user prompt
- Save a trace

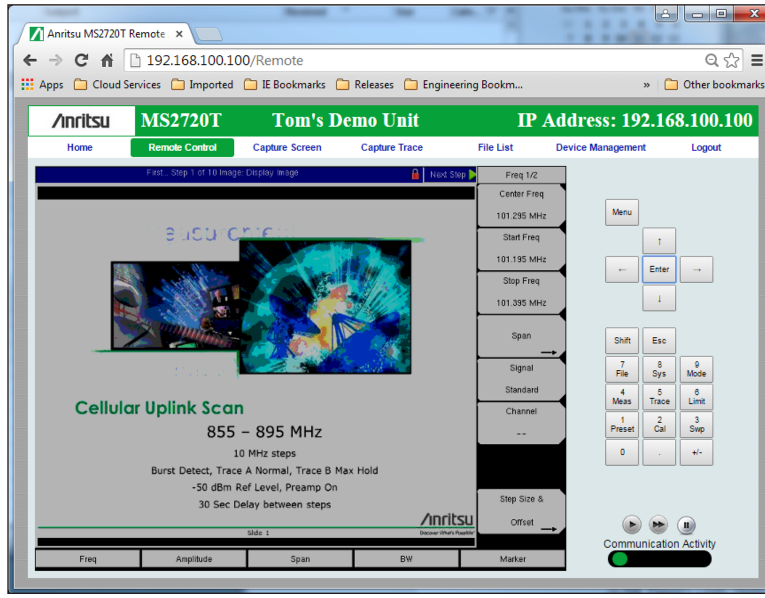

Figure 34: An easyTest script running remotely on a MS2720T spectrum analyzer.

That's it. But this provides a lot of flexibility for spectrum monitoring applications. For example, you could record a spectrogram for one band, then record zero span traces for several different frequencies. Scripts can have up to 100 steps, allowing for very complex scenarios.

Advantages of easyTest include:

- Good flexibility
- Usable with all trace types
- Usable in the Spectrum Analyzer, Interference Analyzer, Channel Scanner, and for those instruments that have it, the Cable and Antenna Analyzer modes
- An easyTest script can be e-mailed to a remote site or technician, without needing any other files.

Disadvantages of easyTest include

- Must be planned in advance
- Not that fast between setups

Instructions for creating an easyTest script can be found on YouTube by searching for “Anritsu easyTest Tools” While the video is focused on a Site Master script, the techique described works for the Spectrum Master line of insturments as well. Further information can be found on Anritsu easyTest Tools web page.

Spectrum Analyzer Remote Control

Web Remote Control

Anritsu Spectrum Masters come with built-in remote control capability through their Ethernet port. All that is needed is to direct an HTML - 5 Compliant browser to the instrument's IP address. All instrument controls are accessible. You can even download files directly to your PC using the browser.

For remote monitoring, an Ethernet link to the instrument is required. The instrument is capable of either responding to a DHCP server and using a dynamic IP address or accepting a static IP address. A static IP address is recommended for remote control, because you will be typing the address into your browser's URL window. For long distance Ethernet links, Anritsu recommends the assistance of an IT person when setting up because the process can be complex.

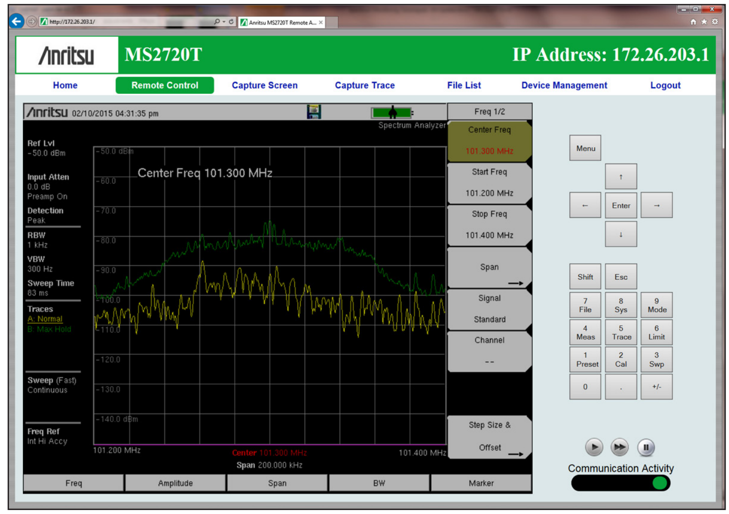

Figure 35: A Spectrum Master being controlled by Web Remote Tools over a Wi-Fi link.

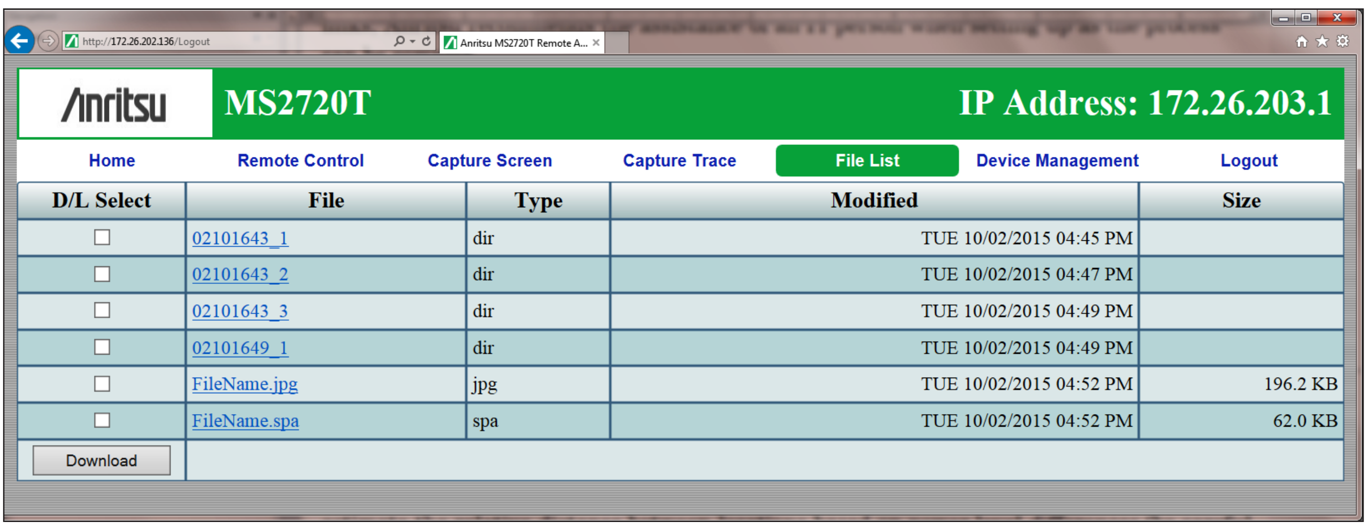

Figure 36: Downloading multiple files or even complete directories is easy via the built-in HTML-5 web browser.

If the need is for remote monitoring over a short distance, say less than 300 feet (100 meters), a Wi-Fi link can be used to advantage. The Anritsu application note "Anritsu Spectrum Master with Web Remote Tools" details how to set this up, as well as how to download captured files and work with lower-bandwidth links. Also, Anritsu has published a YouTube video clip on using Web Remote Tools.

Signal Location

Spectrum monitoring is often the first step is locating an offending signal. If you have a directional antenna, you can get an approximate bearing to the signal location. If you have receivers at multiple locations, or can move one receiver between locations, you can estimate the relative distance between locations based on power level differences (be careful of antenna gain or TMA gain differences when doing this). Often, this is enough to get you started with the next step—driving to the emitter location. The Anritsu MX280007A Mobile Interference Hunting System can help with this step. This system combines a spectrum analyzer and a simple antenna along with software that helps direct you to the emitter location quickly and easily. After you are close enough to the emitter to park your vehicle, you can then use the same spectrum analyzer on foot, along with the MA2700A Handheld InterferenceHunter™, to find the exact emitter location.

Selecting a Spectrum Monitoring Tool

Many spectrum monitoring tools are available today. With all the instruments available, making an informed choice can be challenging. Here are a few guidelines for selecting a spectrum monitoring instrument, whether it be a receiver or a spectrum analyzer.

It is important to pay attention to specifications and features. Missing or sparse specifications are a warning sign of a low quality instrument. Specifications that are present, but poor, can be harder to interpret. At the same time, some specific features may distinguish one tool from another. Here are a few pointers:

Third Order Intercept (TOI)

Instruments with poor TOI will be more susceptible to generating spurious responses (spurs) internally that may be confused with real, external, signals. In other words, the effect of an overload, or near-overload, shows up sooner and is more pronounced. A good TOI figure is in the 15 to 20 dBm range, with two –20 dBm tones and no attenuation. Be wary of instruments that specify TOI with >0 dB attenuation, because this makes the TOI number artificially high.

Phase Noise

Excessive Phase Noise shows up as an elevated noise floor near any strong signal. This may mask a weak signal at a frequency near a strong signal. A good phase noise specification means that this effect will be minimized. An example of a good phase noise figure is –100 dBc/Hz at 1 GHz.

DANL

Instruments with a poor Displayed Average Noise Level (DANL) may not be able to see a low level signal due to a high noise floor. In any given RBW, their noise floor will be higher than an instrument with a lower DANL. This tends to mask low level signals. A counter-argument is “Well, if the signal is that small, we don’t need to worry about it.” It is good to remember that a signal that is weak in one location may be strong in another location, and you may be in the location where the signal is weak. The DANL is often specified in a 1 Hz bandwidth, which allows you to easily estimate the noise floor of different instruments at any RBW setting. A good DANL is quite helpful when setting up a spectrum monitoring station or network, ensuring that you can effectively monitor signals over a wider area. An example of a good DANL specification is a number less than –160 dBm in a 1 Hz RBW. Remember also that when setting up a monitoring network, having a noise floor or DANL that is 3 dB better may mean that you need only have half as many monitoring stations.

Dynamic Range

A large Dynamic Range allows you to see a small signal when a large signal is also present. This is essential if the signal you are interested in is small and close in frequency to a large signal. This condition is often the case in a communications system. Unfortunately, dynamic range for a spectrum analyzer can be specified in many different ways with wildly different numbers. One example of a very useful Dynamic Range specification is “greater than 106 dB in a 1 Hz RBW”, using the method “2/3(TOI-DANL)”.

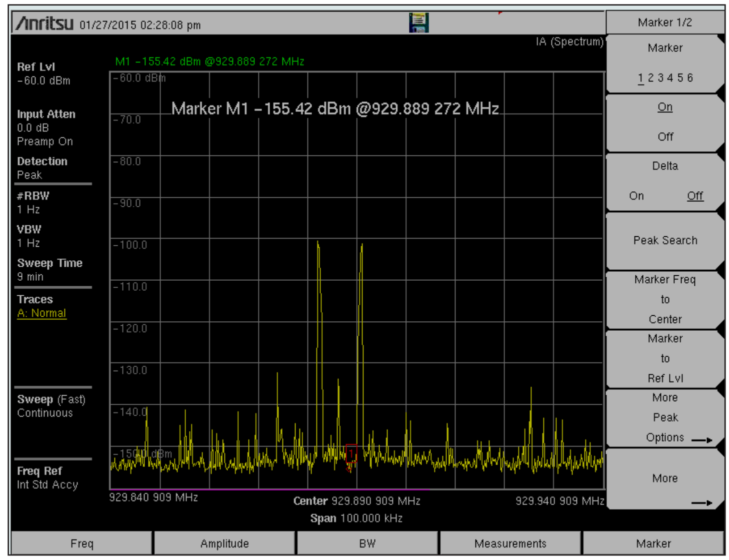

Figure 37. A low noise floor, good dynamic range, and low phase noise, allow spotting weak signals even though strong signals are present.

Overload Indicator

It is important that your chosen instrument indicate when its front-end is experiencing overload conditions. A front-end overload is quite possible when receiving signals through an antenna and may be generated by a signal that is not even visible in the current span. Overloads may generate spurious signals (spurs) that appear to be legitimate signals, and these signals are made worse by poor TOI. If you know that an overload is occurring, you can add attenuation, external band-pass filters, or even move to a different location. If you do not know that an overload is happening, you may waste a lot of time investigating signals that are generated inside the instrument itself!

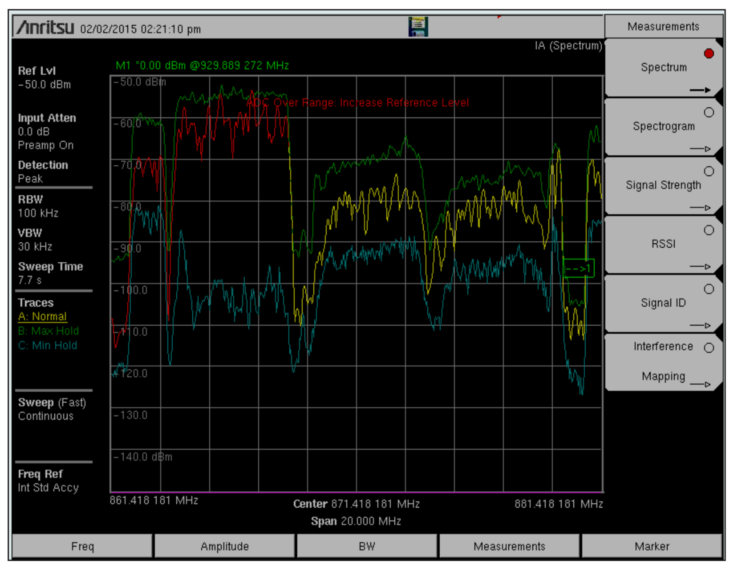

Figure 38. An overload indication, shown in red, is an essential guide to setting your input attenuation, setting the pre-amp, or selecting a pre-filter.

Multi-step Attenuator

A wide range attenuator, with many different possible attenuation values, is a fundamental tool when monitoring spectra. As you may recall from the section on setting the input level, attenuation is the first step when dealing with an input overload. Some instruments have few or no attenuation settings, making it difficult to see low level signals after enabling the attenuator. Coarse attenuation selections also make dealing with input overloads more difficult.

Preamplifier

Weak signals may need preamplification before becoming visible. The difference can be dramatic, lowering the apparent noise floor by about 10 dB. It is important that the preamplifier be wide range, preferably the full range of the instrument. Anritsu handheld spectrum analyzers limit the maximum attenuation when using the preamp, to help you avoid setups that degrade the dynamic range of the instrument.

Burst Detect

Burst Detect makes spotting or even locating signals that are intermittent much easier and much faster. It is quite helpful to have a way to see bursty signals quickly because many of the current generation of digital signals are bursty in one form or another.

Video Bandwidth Control

Some monitoring tools do not have a Video Bandwidth (VBW) setting. This makes it more difficult to deal with modern digital signals. A VBW filter is a fast way to average the displayed data and lower the noise floor. A user-adjustable VBW filter is an important feature when selecting a tool to monitor in the current RF environment.

User Interface

While no one likes to think that a user interface would make the difference between a usable and an unusable instrument, the user interface truly has a great deal to do with how comfortable you feel with the instrument. Most spectrum analyzers have a user interface that is similar to other spectrum analyzers. While there is not a standard spectrum analyzer user interface, if you learn to use one spectrum analyzer, you know most of what you need to use a different spectrum analyzer. This has been worked out over time and many trials to be an efficient user interface. If you are considering an instrument with an unusual user interface, be sure to carefully consider both the learning curve and how easy it may be to do common tasks—both for yourself and others in your organization.

Figure 39: Make true isotropic field strength measurements with an Anritsu isotropic antenna and option 444 on the spectrum analyzer.

Field Strength Measurements

If coverage or exposure limits are important, you will want to be able to measure in field strength units. This capability normally includes an automatically calculated correction for the antenna gain factors as well as automatically converting measurements into field strength units such as Watts per Meter Squared. This is a real time saver if accurate, repeatable field strength measurements are required. In some countries, an isotropic antenna and averaging over several wavelengths are necessary. Anritsu handheld spectrum analyzers with option 444 and the appropriate antenna address this need as well.

Spectrum Recording

Not all spectrum measurement devices allow saving traces, saving spectrograms, or save-on-event. If you are in a position where it is necessary to compare measurements or report on measurements, the ability to save traces, either normally, though save-on-event, or within a spectrogram, will be important.

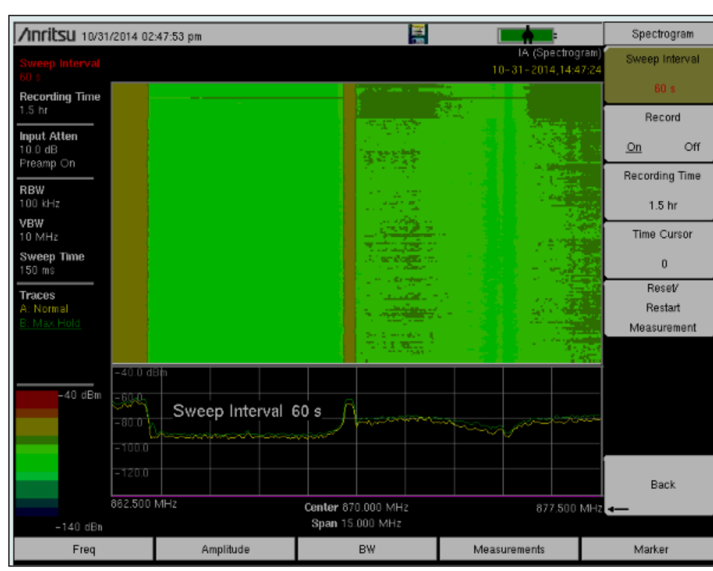

Figure 40: Spectrogram recording is an essential part of spectrum monitoring.

Conclusion

Spectrum monitoring has long been an established tool for spectrum management. The move to digital modulations and the drive to an "always connected" society have made the need for spectrum monitoring even more important. Monitoring can help resolve issues in the areas of interference, capacity, and reliability, and help regulate unlicensed use of the spectrum.

A well thought out spectrum monitoring tool, such as an Anritsu spectrum analyzer, is essential for this task. With a variety of sweep modes, Burst Detect, essential warning messages, task automation, and full remote control over Ethernet, Anritsu spectrum analyzers are well suited to this task.

Anritsu is prepared to assist you with your spectrum monitoring tasks and needs.

NOTES

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