Expand Your Spectrum Monitoring Capability with Affordable Performance

Wireless technology powers the modern world. From Wi-Fi to Bluetooth, satellites to smart phones, and automobiles to homes, every year it becomes more vital and ubiquitous. When signals interfere with one another data rates plummet, connections drop, errors multiply, range decreases, pathways become noisy, and information exchange slows. The consequences can range from annoying to catastrophic.

USB-SA44B
1 Hz to 4.4 GHz spectrum analyzer

BB60C
9 kHz to 6 GHz spectrum analyzer

SM200A
100 kHz to 20 GHz spectrum analyzer

Figure 1— Signal Hound offers a range of spectrum analyzers to meet your performance needs.

To keep from bumping into one another, signals ideally stay in their designated frequency lanes, do not exceed their allowed amplitudes, and conform to other relevant protocols. Add to that illegal transmissions, unlicensed spectrum usage, leakage from all manner of devices, and the situation gets tricky. Across a wide range of spectrum monitoring applications, high-end spectrum analysis has become a necessity. The need for affordable spectrum analyzer performance to monitor, manage, troubleshoot, and protect RF spectrum in the field has become a critical factor for success.

Signal Hound spectrum analyzers meet your key requirements of performance and affordability, plus they can easily be integrated into your monitoring system. Our open-systems approach provides a highly extensible platform for creating custom-tailored spectrum analysis applications.

This paper provides an overview of the most common spectrum monitoring applications our customers address. We review the key requirements used to determine which spectrum analyzer meets their objectives. Finally, we discuss how companies are extending their specialized applications with Signal Hound spectrum analyzers to address their unique requirements.

A **Technical Brief** from Signal Hound®

Spectrum Monitoring Applications

Across a wide range of industry and specialized applications, high-end spectrum analysis has become a "go anywhere" necessity for supporting field and remote deployments. Signal Hound is working closely with our customers in a wide variety of areas including the following spectrum monitoring applications.

Government Regulation of Spectrum

In today's increasingly crowded and globalized wireless environment, effective governmental regulation and spectrum management is both critical for international success and very difficult to accomplish. Governments need to have the most advanced capabilities for field-based spectrum analysis and remote deployment in order to stay ahead of the curve, to catch violators, and to resolve disputes.

Being able to expand their deployment of low cost remote signal monitoring systems that remain in the field and deliver data, analytics, and alerts to centralized locations is key. Not only do these systems need to be affordable enough for multi-unit deployments at key points in the communications infrastructure; they also need to be designed for seamless remote management, such as power cycling, system recovery and pushing out software updates without requiring a truck roll with a field technician.

Technical Surveillance Counter Measures (TSCM)

Along similar lines, there are a growing number of independent groups that provide technical surveillance counter measure (TSCM) capabilities – they look for bugs or hidden listening devices. Affordable portable spectrum analyzers with high dynamic range and low phase noise are key to ensure corporate boardrooms or other sensitive business locations are free from outside listeners.

Figure 2—Today's increasingly crowded and globalized wireless environment requires effective governmental regulation and spectrum management.

Covert Spectrum Analysis

SIGINT operations are an important specialized area of the government's covert agencies. For these applications, spectrum analysis systems need the greatest degree of remote hardware flexibility and overall system extensibility. Depending on the deployment scenario, remote covert signal analysis systems may need to operate independently for long periods of time and respond to specific software-defined parameters that are unique to each situation. For example, a remote spectrum analysis system might need to scan for signals at certain frequencies and then begin RF recording or streaming the data only under those conditions. Some covert scenarios could even require the remote general software to recognize patterns of associated frequencies, modulations, and/or signals activity to trigger actions by the remote computing platform.

Frequency Coordination

Today, many live events rely on wireless technologies to enhance their customer's experience. Sporting events are not only attended by tens of thousands of people, but are watched on television by millions more. Ensuring that the quarterback hears the play, or the officials can communicate their rulings, is key to the event's success. The same is true for wireless guitars and microphones at concerts, as well as microphones etc. for live television events.

Field engineers/technicians need the ability to detect and analyze signals in support of installation, monitoring or troubleshooting activities. The proliferation of systems that use spectrum and/or could interfere with other wireless applications makes it imperative that they be able to detect, analyze, diagnose, and correct any signal problems or interference issues in a variety of field environments.

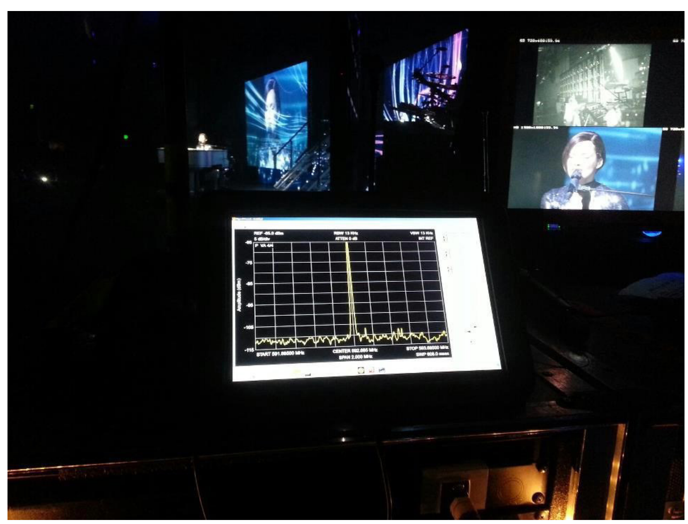

Figure 3—Key to a live event's success is ensuring the reliability of the wireless technologies.

Factory Ecosystems

Portable spectrum monitoring has also become important for QA testing within extended-factory ecosystems where signal performance needs to be evaluated for systems in multiple production lines and/or by QA engineers conducting vendor site visits. Sometimes customer service and QA functions need the ability to stream data from remote locations to centralized facilities for additional real-time analysis or to record streamed RF to disk on the field device for subsequent archiving and system-wide trends analysis. In QA or customer service situations, the ability to network and integrate field analyzers with backend resources can be critical for not only solving immediate problems, but also for identifying emerging issues to avoid the cost of widespread corrective measures.

Key Requirements

Performance

The first requirement for any spectrum analyzer is its ability to deliver the performance needed for a variety spectrum monitoring applications. Fall short on these performance requirements and nothing else matters.

Sweep Speed

For spectrum monitoring, sweep speed is of critical importance. Certain situations require broad frequency sweeps in search of a variety of signal situations. **Table 1** highlights the sweep speeds for each of our spectrum analyzers. Signal Hound's SM200A offers an industry leading 1 THz/sec sweep speed at any of its resolution bandwidth settings ≥30 kHz. Covering 1 GHz to 20 GHz in just 19 milliseconds allows for a constant sweep of the airwaves. This is different from other fast spectrum analyzers in that the SM200A suffers from no blind time or retrace time between sweeps. This is due to a very agile local oscillator in the SM200A. By buffering or queuing several sweeps on the SM200A, the analyzer can sustain its maximum sweep speed. This fast sweep speed can be performed in the Spike software or with the devices programming interface. With a sustained 1THz/s sweep speed the SM200A can monitor a 2GHz span with a 100% probability of intercept for signals lasting 2 milliseconds or longer. This means that any signal event lasting 2ms or longer will be captured in the spectrum.

Table 1—Sweep Speeds

Analyzer	Sweep Speeds
Signal Hound SA44B	140 MHz/s ≥ 10 kHz RBW
Signal Hound BB60C	24 GHz/s ≥ 30 kHz RBW
Signal Hound SM200A	1 THz/s ≥ 30 kHz RBW

Dynamic Range

Dynamic range is an important specification that determines what signals can be distinguished from the spectrum analyzer's noise floor. An important consideration is to determine how low a level is needed for your monitoring situation. **Figure 4** highlights the importance of dynamic range when looking for low level signals. If you are trying to make sure your spectrum is clear enough for a live performance, then maybe 60 dB meets your need. However, if you are doing Technical Surveillance Counter Measures (TSCM) testing, the lower your noise floor the better.

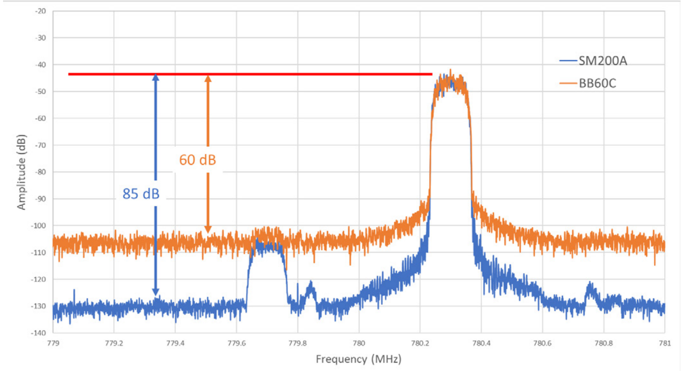

Figure 4—What is your system's noise floor requirement? Do you need to accurately locate signals more than 60 dB down? More than 85 dB?

Phase Noise

Low phase noise compliments the dynamic range in that a spectrum analyzer can only distinguish signals that are above the unit's phase noise. Table 2 highlights the phase noise performance across our spectrum analyzers. The Signal Hound SM200A uses a low IF architecture, making it inherently less expensive to achieve exceptional phase noise performance. The Signal Hound SA44 and BB60 use a more traditional superheterodyne architecture which yields more modest phase noise performance at an even lower price. Note that for the SA44, the results listed are typical as it does not have a hard spec for phase noise.

Table 2—SSB Phase Noise for a 1GHz Carrier

Offset	SA44B (Typical)	BB60C (Spec)	SM200A (Spec)
10 Hz			-76
100 Hz	-80	-70	-108
1 kHz	-88	-76	-123
10 kHz	-91	-83	-132
100 kHz	-100	-93	-136
1 MHz			-133

The low IF architecture of the SM200A enables exceptional phase noise performance with a lower cost design, but it does come with a tradeoff of higher image response spurs. The SM200A Spike software provides a Signal ID feature to be activated and deactivated to allow low level mixer spurs to be differentiated from incoming signals (Table 3). In many cases the spurs can be identified as coming from the spectrum analyzer, allowing them to be ignored during the actual measurement. The more traditional superheterodyne architecture of the BB60C typically has 70 dB image rejection. The BB60C spurs are generally not from the image response.

Table 3—SM200A Image Response Signal ID Feature

	Signal Hound SM200A	
Frequency	Image Reject Off	Image Reject On
100 kHz to 6 GHz	-58 dBc	-75 (typ)
6 GHz to 10 GHz	-55 dBc	-75 (typ)
10 GHz to 20 GHz	-44 dBc	-75 (typ)

Instantaneous Bandwidth

Instantaneous or real-time bandwidth is especially important when looking for fast moving intermittent signals. Signal Hound offers real-time spectrum analysis capabilities with up to 160 MHz of instantaneous bandwidth (IBW) and a 100 percent probability of intercepting signals as fast as 10-microseconds. The amount of instantaneous bandwidth you need will depend on the bandwidth of the signals you are trying to detect. **Table 4** highlights the real-time analysis capabilities of the Signal Hound spectrum analyzers.

Table 4—Real-time Spectrum Analysis Capabilities

Analyzer	Real-Time BW	100% Prob of Intercept (POI)
SA44B 4.4 GHz	250 kHz	592 µs @ 10 kHz RBW 4.7 ms @ 1 kHz RBW
BB60C 6 GHz	27 MHz	19.2 µs @ 300 kHz RBW 38.4 µs @ 100 kHz RBW
SM200A 20 GHz	160 MHz	12 µs @ 300 kHz RBW 49 µs @ 100 kHz RBW

Lower Cost per Station

The growing use of wireless technologies is increasing the need for spectrum monitoring applications. Along with the increased interest is a need to drive down the cost per monitoring station. Signal Hound's architectural approach is providing a level of overall system price versus performance value that breaks through the cost barriers posed by conventional one-box systems. This is creating new opportunities for wider field usage and enabling more cost-efficient remote deployments.

For remotely deployed scenarios, the lower cost is an enabling factor that makes it possible to put remote systems in the field where the cost of standalone analyzers was simply too prohibitive. This means that communications service providers can cost-effectively push high-end embedded spectrum management further out into their infrastructure, thereby increasing the number of deployed sensors while simultaneously improving customer satisfaction.

System Integration

Signal Hound's open-systems approach provides a highly extensible platform for creating custom-tailored spectrum analysis applications. Companies with specialized applications can easily extend the basic analysis software that comes with the product to address their unique requirements. Since the APIs are fully documented and programmable in C/C++, virtually any set of custom functions can be created, deployed, and maintained by programmers who become familiar with the concepts of making basic RF measurements.

Easily Programmable

Many spectrum monitoring solutions are controlled via an overall software application. It is important that the spectrum analyzer nodes can easily be programmed into this unique environment. All Signal Hound spectrum analyzers can be programmed using three methods (Figure 5). The first two employ Standard Commands for Programmable Instruments (SCPI) commands via Spike software either locally or remotely over the internet. The third is via fast, direct API programming using a device-specific local API. API's are available at no cost for all Signal Hound spectrum analyzers.

Our Spike software provides control of all Signal Hound spectrum analyzers using a common Graphical User Interface (GUI) to offer advanced signal analysis measurement and display. They can be remotely operated via a TCP/IP link. You can connect and interface our spectrum analyzers through any VISA implementation (such as SCPI) or any programming language that allows SOCKET programming.

Traditional programming using Signal Hound-supplied, device-specific API's remains available for fast, direct device control. The device specific APIs use a C interface, and the functions can be called from most modern programming languages and environments such as C/C++, C#, Python, Java, LabVIEW, and MATLAB.

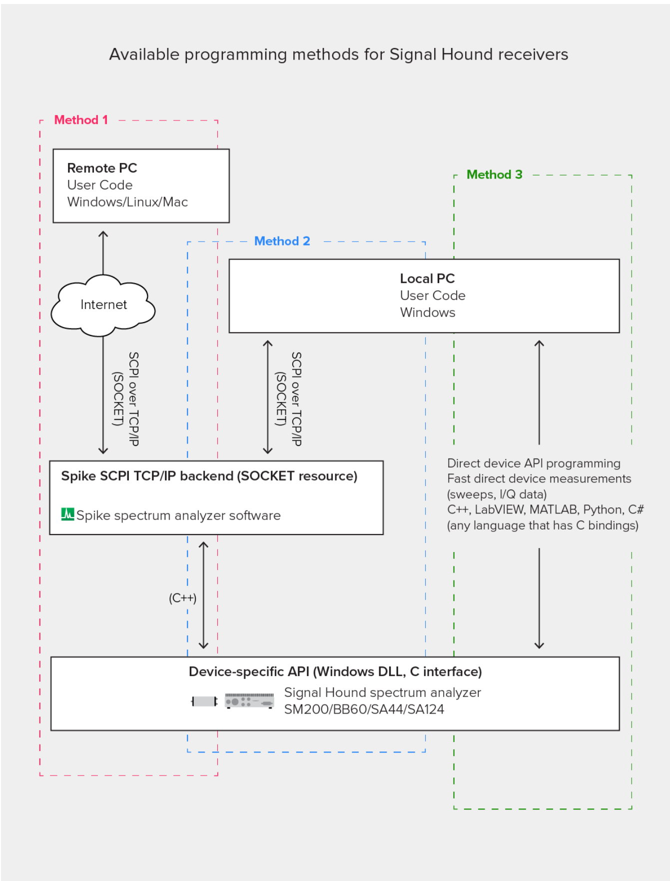

Figure 5—Signal Hound spectrum analyzers can be programmed using three methods, including fast and direct API programming using a device-specific local API.

Remote Control of Monitoring Nodes

With the reduced expense of setting up a spectrum monitoring node, it follows that it must be able to be reset or rebooted without the need for field personnel visiting each node. The monitoring system is connected to the network and backend resources through the PC's Ethernet interface. The Ethernet interface supports the full range of communications, data uploads, software updates, and other system management tasks. By pairing the spectrum analyzer with any Intel vPro-enabled PC, from a high performance desktop to an ultra-compact NUC, the entire system can be managed remotely, including the ability to turn it on and initiate operations. The Intel vPro technology keeps the Ethernet port powered on – even when the PC is shut down – so that it can always receive commands. This makes it possible to perform the following tasks remotely over Ethernet:

- Remotely power cycle the PC – On or Off
- Remotely manage software updates (including restart operations)
- Remotely perform system recovery if the PC or spectrum analyzer crashes or locks up

Figure 6—Signal Hound spectrum analyzers enable you to build applications specifically tailored for remote signal monitoring.

Expanding Capabilities Beyond the Box

Extensibility is very important in today's rapidly changing wireless communications environment, where you need to remotely deploy solutions that can then be adapted to address new requirements simply by remote updates of the software.

Software customization is also a critical factor for creating specialized spectrum analysis functions, such as field-deployed covert SIGINT platforms and governmental regulatory monitoring systems. In these cases, the spectrum analysis applications often need to incorporate complex algorithms to detect, analyze, and prioritize signals of interest.

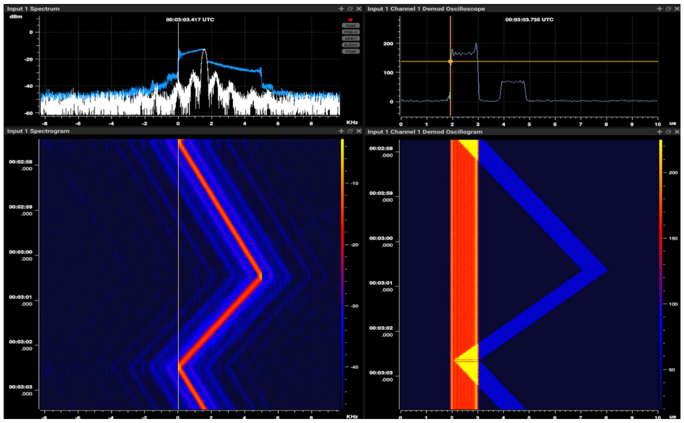

Figure 7—Software customization is a critical factor for creating specialized spectrum analysis functions that may need to incorporate complex algorithms to detect, analyze, and prioritize signals of interest. [SCEPTRE images courtesy of 3dB Labs]

Signal Hound spectrum analyzers send digitized data of the received RF spectrum to the PC where all the signal processing occurs. This architecture has distinct advantages over sensors that perform their signal processing in an FPGA – first, by retaining all modulation information for processing in a PC, and second, by being highly reconfigurable by a large population of programmers. Developing new signal processing algorithms for an FPGA requires far more effort than doing the same thing in a PC. There are also far fewer skilled FPGA programmers than there are skilled C++ programmers, making long term management and system adjustments much easier for PC-based signal processing.

Summary

Managing and maintaining efficient communication networks requires the best tools you can get. The need for an affordable spectrum analyzer with the performance to monitor, manage, troubleshoot, and protect RF spectrum in the field has become a critical factor for success. Signal Hound spectrum analyzers are meeting the need for many of these applications. Our analyzers have been proven successful at meeting the key needs of performance, affordability, and ease of being integrated into the overall monitoring systems.

For full details and purchase information, check out the Signal Hound website at signalhound.com.

Further Reading

Learn more about Signal Hound's robust, real-time USB-powered spectrum analyzers at signalhound.com/learn.

About Signal Hound

The Signal Hound® company started as Test Equipment Plus (TEP) in 1996 with the belief that providing quality used test equipment, at affordable prices to every customer, would drive growth and foster loyal customers. It did. Then in 2006, TEP expanded their focus by designing and manufacturing a color LCD display retrofit kit to answer the need for CRTs that were no longer available for the aging HP® 8566A, 8566B, 8568A, and 8568B spectrum analyzers. TEP also began offering a repair service for HP/Agilent® step attenuators. In 2007 TEP designed and began manufacturing another color LCD display retrofit kit to support the HP/Agilent 8560 series spectrum analyzers. At the same time, TEP also decided to play to their strengths, and began offering test equipment repair services for Agilent spectrum analyzers, network analyzers, and signal generators.

The LCD kits were so well received that in 2009, TEP decided to design a compact, lightweight, and inexpensive spectrum analyzer. The goal was to provide an economical spectrum analyzer with unparalleled value compared to anything else on the market. TEP achieved that goal with the USB-SA44 spectrum analyzer which was introduced in February 2010, marking the birth of the Signal Hound line of test equipment. In April of 2014, Test Equipment Plus officially began doing business as Signal Hound, with Signal Hound subsequently selling Test Equipment Plus in May 2018. Signal Hound's latest innovation is the SM200A spectrum analyzer, introduced in February 2018, which is a 20 GHz high-performance spectrum analyzer with applications from spectrum monitoring to benchtop RF analysis.

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