Application Note

Build Applications Tailored for Remote Signal Monitoring with the Signal Hound BB60C

By Justin Crooks and Bruce Devine, Signal Hound — July 21, 2015

Introduction

The Signal Hound BB60C Spectrum Analyzer is well suited for applications that require remote operation. The following table shows key specifications for the BB60C:

BB60C SPECIFICATIONS SUMMARY	
Frequency Range	9 kHz to 6 GHz
Streaming Digitized I/Q	25 kHz up to 27 MHz of selectable, amplitude corrected, IF bandwidth
Resolution Bandwidths (RBW)	10 Hz to 10 MHz
Sweep Speed (RBW ≥10 kHz)	24 GHz/sec
Displayed Average Noise Level (DANL)	-158 dBm/Hz + 1.1 dB/GHz (>10 MHz)
Residual Responses: Ref Level ≤ -50 dBm, 0 dB Atten	-103 dBm (>500 kHz)
Spurious Mixer Responses: (ref level -50 to +10 dBm (any 5dB increment) and input signal 10 dB below reference level	-50 dBc
Operating Temperature, ambient	32°F to 149°F (0°C to +65°C) Standard -40°F to 149°F (-40°C to +65°C) Option-1

The Signal Hound BB60C operates and is powered by connecting to a host PC through a USB 3.0 cable. Remote spectrum analyzer and PC management tasks are accomplished over an Ethernet connection through the use of a low cost Intel vPro- enabled PC, such as the Intel 3rd Gen NUC (Core i5-3427U processor) model DC53427HYE or the newer low-power Intel 5th Gen NUC (Core i5-5300U processor) model NUC5I5MYHE, paired with each BB60C. Intel's vPro technology keeps the Ethernet port powered on, even when the Core i5 processor is turned off, so that it can always receive commands. This makes it possible to perform all of the following tasks remotely over Ethernet:

(A) remotely power cycle the PC off and on;

(B) remotely perform system recovery if PC or BB60C crashes or locks up, and

(C) remotely manage software updates.

The Signal Hound BB60C and a vPro-enabled PC can either be packaged together into an IP67 weatherproof enclosure and mounted on a roof or pole such as a street light, or they can be deployed in the attic or ceiling of a building.

The Signal Hound BB60C sends digitized data of the received RF spectrum to the PC where all of the signal processing occurs. This architecture has distinct advantages—over sensors that perform their signal processing in an FPGA—first, of retaining all modulation information, and second, also 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.

There is also an inherent and significant cost savings associated with signal processing in a PC as compared to an FPGA. An FPGA that is adequate to do a broad range of dynamic spectrum access signal processing tasks will cost the manufacturer anywhere from $250 to $1,000. This cost has to be passed on to the customer at a markup of at least 400%, raising the price of FPGA-based sensors anywhere from $1,000 to $4,000. PC-based signal processing can be done using an inexpensive Intel Core i5 vPro-enabled computer module, that already has an SSD and DDR3 RAM included, for only $750 in single unit quantity.

API Enables Custom Applications for Remote Monitoring

The Signal Hound BB60C Application Programming Interface (API) exposes all of the functionality of the BB60C. This enables the development of custom applications to meet the specific needs of remote signal monitoring. We offer a sample application with source code for getting started, and tips that can help in building and deploying a successful application. The sample application is structured so that the remote Signal Hound BB60C and vPro-enabled computer are functioning as the server and the human operator's computer is functioning as the client.

Standard Swept Spectrum Analysis over a Remote Connection

Swept analysis represents the most traditional form of spectrum analysis. This mode returns two arrays, representing the minimum and maximum amplitudes at each frequency point, or bin, within your sweep. As it is a blocking call, implementing sweeps over a remote connection can be as simple as requesting the sweep from the remote computer and waiting for the data.

The size of the arrays returned, and the sweep time is affected by span, RBW, and VBW, and can be fairly large. Refer to the following table for a partial list of standard array sizes:

STNDARD DATA ARRAY SIZES				
Span (MHz)	**RBW (kHz)**	**Sweep Time (ms)**	**Number of Points**	**Sweep Size (kb)**
100	1	85	327680	5120
100	30	13	20480	320
1000	10	58	409600	6400
1000	100	50	51200	800
6000	300	220	76800	1200

Each point in the sweep is represented by two, double-precision floating point numbers, each of which requires 8 bytes. This gives you only 64 frequency points (bins) per kB of data. This may require more bandwidth than your remote link is capable of providing. Depending on your application, you may be able to mitigate this bottleneck using one or more of the following approaches:

- Increasing RBW to decrease the number of points
- Increasing sweep time to decrease the number of sweeps per second
- Omitting data points below a certain threshold
- Converting double precision floating point amplitudes to 8- 16- or 32-bit values
- Collecting several sweeps and reporting only the maximum or average amplitude in each bin

Real-Time Spectrum Analysis over a Remote Connection

The API provides the functionality of an online real-time spectrum analyzer for a 27 MHz bandwidth. Through the use of FFTs at an overlapping rate of 75%, the spectrum results have no blind time (100% probability of intercept). Due to the demands in processing, restrictions are placed on resolution bandwidth, and video bandwidth is system-controlled.

In this mode, sweep time is directly controlled, and represents the interval at which sweeps will be reported. Typical sweep time will range from 1 to 128 milliseconds. The sweeps that are reported represent a composite of many FFTs calculated during this interval, where the maximum and minimum or average amplitudes for each bin are reported. Refer to the following table for a partial list of real-time array sizes:

REAL-TIME DATA ARRAYS			
Span (MHz)	**RBW (kHz)**	**Number of Points**	**Sweep Size (kb)**
1	9.9	205	3.2
5	9.9	1024	16
20	2.47	16384	256
20	9.9	4096	64
20	316	128	2

It is important for the local computer to keep up with the sweeps to avoid buffer overflow and data loss, so your application must make provisions for timely calls to bbFetchTrace. To reduce the amount of data to transfer over a remote link, increase RBW, decrease span, and/or increase sweep time.

Another approach that would scale well with any connection rate would be to:

1. Collect traces on the local PC

2. Build a composite trace using min/max/average

3. Wait until the last trace has completed its transfer

4. Send the composite trace and begin collecting the next

This preserves the real-time, continuous spectral coverage while allowing for slower connection rates.

Streaming and Modulation Analysis over a Remote Link

The API is capable of providing a continuous stream of digitized complex I/Q data with an IF bandwidth of up to 27 MHz. Floating-point I/Q sample rates of up to 40 MSPS are supported.

Streaming the full 27 MHz of IF bandwidth produces 320 MB/sec of data, which is impractical for most remote connections. However, by reducing bandwidth to 250 kHz and converting to 16-bit samples, this can be reduced to 1.25 MB/sec, a more manageable number for a typical high-speed connection.

Where the full 27 MHz of IF bandwidth is desired, capturing even a few milliseconds of data can usually provide enough information about bandwidth and modulation characteristics to classify the signal. If even this is too much data to be practical, more intelligent software can be installed on the remote PC, performing modulation analysis at the remote location, requiring only the results to be transferred.

Conclusions

The Signal Hound BB60C, with its API, enables the user to build applications specifically tailored for remote signal monitoring. Specific provisions may need to be made to reduce the immense amount of data the BB60C is capable of producing in some modes, but even powerful features like real-time spectrum analysis can be realized over a remote link.

Further Reading

Download the BB60C API manual from www.SignalHound.com.

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 repair segment of TEP is now recognized in the RF and microwave test equipment industry as a world class operation.

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 began officially doing business as Signal Hound. Signal Hound's latest innovation is the Signal Hound BB60C spectrum analyzer, introduced June 2014, which is an enhanced version of its well-received predecessor, the BB60A.

USA: 1.800.260.TEST
INTL: 001.360.263.5006
www.SignalHound.com

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