BB60D Spectrum Analyzer
Product Manual

Signal Hound BB60D User Manual

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Contents

1 Overview

This document outlines the operation and functionality of the BB60D Signal Hound spectrum analyzer. This document will help you understand the capabilities, performance specifications, and features of your BB60D.

1.1 What's New

The BB60D is a significant improvement over the BB60C. The BB60D has a preselector, better dynamic range, better phase noise, and lower residual spurious signal levels. The BB60D has a dedicated 10 MHz input and additional digital output options.

2 Preparation

The BB60D is a real-time high-speed spectrum analyzer communicating with your PC over a USB 3.0 Super Speed link. It has 27 MHz of real-time bandwidth, tunes from 9 kHz to 6 GHz, collects 80 million samples per second, and streams data to your computer at 140 MB/sec. By adding a high-speed hard drive to your PC or laptop (250 MB/s sustained write speed), the BB60D doubles as an RF recorder, streaming up to 80 million IF samples per second, or 40 million I/Q samples to disk.

2.1 Initial Inspection

Check your package for shipping damage before opening. Your box should contain a USB 3.0 Y-cable, a CD-ROM, and a Signal Hound BB60D.

2.2 Software Installation

See the Spike Software manual for installation instructions. You must have administrator privileges to install the software. During installation, the BB60 device drivers will also be installed.

It is recommended to install the application folder in the default location.

2.2.1 Software Requirements

These system requirements cover the use of the Spike software with the BB60D.

Recommended System Requirements

- Windows 10/11 64-bit or 64-bit Ubuntu Linux 18.04 or newer
- Processor – 4th generation or newer Intel desktop quad-core i-series processors***
- Minimum of 8 GB RAM, 1GB typical for the Spike software

- Native USB 3.0 support†
- OpenGL 3.0 capable graphics processor**

(We do not recommend running the BB60 in a virtual machine (i.e. Parallels/VMWare/etc.))*
*(** Certain display features are accelerated with this functionality, but it is not required.)*
*(***Our software is optimized for Intel CPUs. We recommend them exclusively.)*
(† Early USB 3.0 controllers from Renesas and ASMedia do not function well with our BB60. Native USB 3.0 hardware is used to refer to Intel's USB 3.0 controllers found on 3rd generation or newer i-series processors.)

2.3 Connecting Your Signal Hound

With the software and BB60 drivers installed, you are ready to connect your device. Plug in both the male USB 3.0 and male USB 2.0 connections into your PCs respective USB ports, and then plug the USB 3.0 Micro-B male connection into the BB60 device. Your PC may take a few seconds recognizing the device and installing any last drivers. Wait for this process to complete before launching the Spike software.

2.3.1 Option 10

For option 10, external 5V input, plug in the USB cable before your external power supply (not included). To power down, unplug the external power before the USB cable.

2.4 The BB60 Front and Rear Panels

The **front panel** includes a 50Ω SMA RF Input. Do not exceed +20 dBm or damage may occur. A READY/BUSY LED flashes from green to orange each time a command from the computer is processed.

The **rear panel** has three connectors:

1. 10 MHz Reference input (SMA). Use a clean 10 MHz reference sine wave or square wave with >0 dBm level. A +13 dBm sine wave input or 3.3V CMOS clock input is recommended.

2. A USB 3.0 Micro-B female connector. Use the Y-cable provided to connect the device to your PC.

3. A multi-purpose SMA connector for signal I/O, primarily for trigger input, including GPS 1 pulse per second (PPS) trigger, and external trigger in zero span mode. May also be used as a general purpose 3.3V logic output, to send UART commands, or to output a 10 MHz signal.

The BB60D is a hybrid superheterodyne-FFT spectrum analyzer with preselector. The BB60D uses a local oscillator and band-pass filters to convert a portion of the input spectrum into an intermediate frequency (IF). The intermediate frequency is then sent from the device to the host PC where it undergoes FFT spectrum analysis transforming the input IF into a frequency spectrum. The resulting IF contains 27MHz of usable bandwidth.

The BB60D is also a real-time spectrum analyzer. This means the device is capable of continuously streaming the IF frequency with no time gaps. Having no time gaps is critical for measurements and tests requiring high probability of intercept (POI). See the section below **Real-Time Spectrum Analysis** for a more in-depth discussion of the BB60 capabilities.

The BB60D offers multiple modes of operation, available in both our Spike software and API. See the Spike software manual and BB60 API manuals for more information

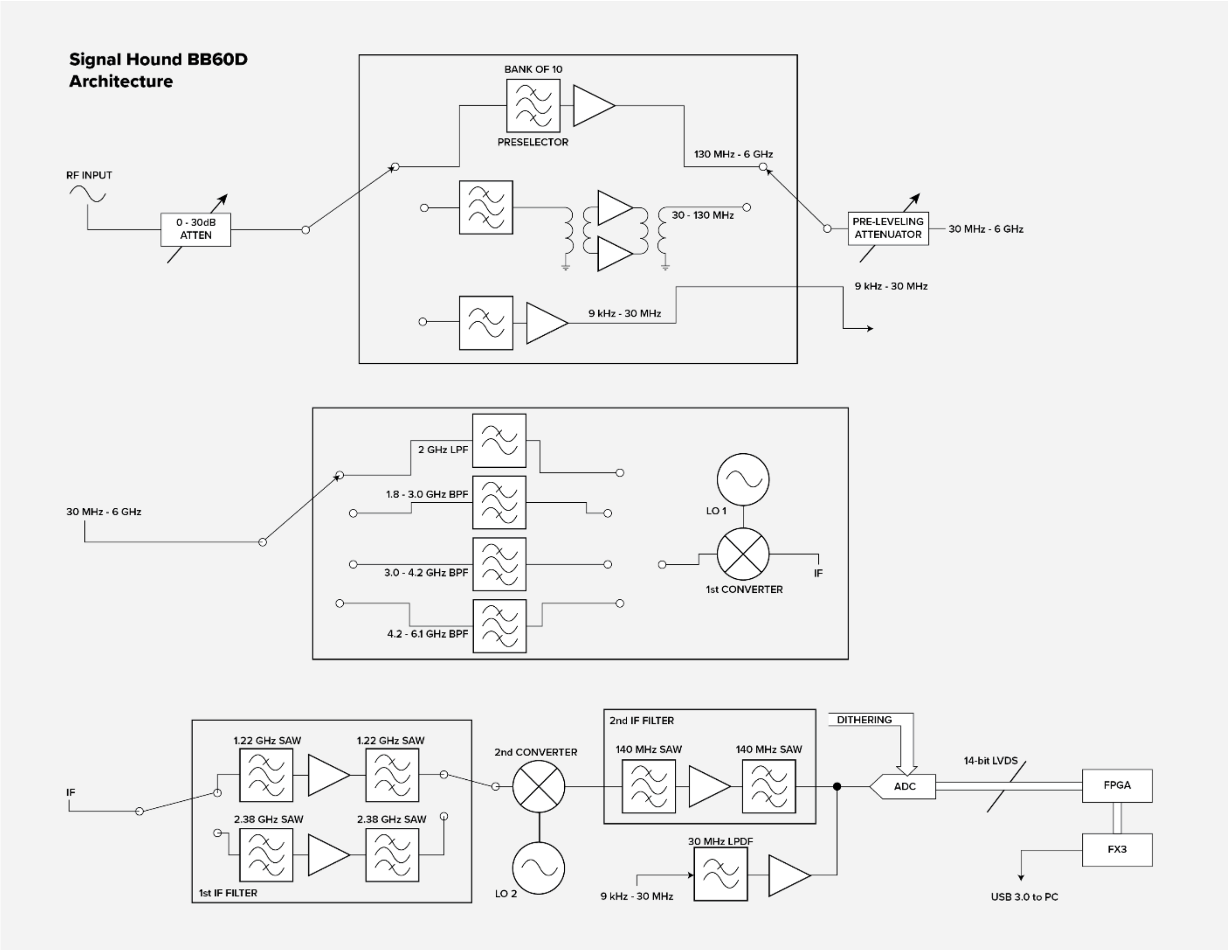
When paired with a USB-TG44A, or a USB-TG124A, the BB60D may be used as a scalar network analyzer. See the Spike software manual for more information. The BB60D is not recommended for scalar network analysis measurements below 100 kHz.

2.4.1 Option 10

Option 10 power input requires a 5V 2A AC/DC adapter with a FGG.0B.302.CLAD42 LEMO connector.

3 Understanding the BB60D Hardware

3.1 Front End Architecture



3.2 Description

The BB60D is a two-stage superheterodyne receiver, using two independent intermediate frequencies (IF), selected based on RF input frequency. Three separate methods are used to minimize second-order intermodulation products, depending on frequency range. Below 30 MHz, a high linearity, low noise operational amplifier is used, from 30-130 MHz a push-pull amplifier is used, and above 130 MHz a sub-octave preselector is used. The IF frequencies used are 2380 MHz and 1220 MHz.

Intermediate Frequency (IF) used for each range of RF frequencies

RF Frequency Range (MHz)	IF Frequency (MHz)	LO Frequency Range (MHz)
30-1810	2380	2410-4190
1810-4210	1220	3030-5430
4210-5590	2380	6630-8000
5590-6000	1220	6800-7220

Gain control is achieved in the BB60D using the front-end attenuator and RF gain control. The front end was designed to provide good IP2, IP3, noise figure, and intermodulation- and spurious-free dynamic range for frequencies within its operating range. Care was taken to preserve dynamic range as reference level is adjusted, but dynamic range will degrade slightly when reference level exceeds +0 dBm.

The BB60D achieves maximum sensitivity at a reference level of -30 dBm, 20 dB higher than the BB60C. Residual spurious signals at maximum sensitivity are typically below -120 dBm, meaning the noise floor stays clean even at a 1 kHz RBW.

The 14-bit ADC uses built-in dithering to further improve the linearity and decrease spurious responses from the ADC. Spurs from the ADC are typically 70 dB below the carrier.

From the ADC, digitized IF data is handed off to an FPGA where it is packetized. The Cypress FX3 peripheral controller streams the packetized data over a USB 3.0 link to the PC, where 80 million, 14-bit ADC samples per second are processed into a spectrum sweep or I/Q data stream.

The intermediate frequency is filtered out of the RF for every band, but spurious typically below -60 dBc may be observed from input frequencies of 1220±10 MHz, 2380±10 MHz, and 1190±5 MHz.

Shielding has been improved to reduce residual spurious signals to a minimum.

3.3 Scalloping Loss

An FFT-based spectrum analyzer uses digital resolution bandwidths rather than discrete analog filters. Moving from analog to digital introduces some new terms important to measurement accuracy, like FFT bins, window functions, spectral leakage and scalloping loss. To sum up, an FFT produces an array of discrete frequency bins and their associated amplitude. Real-world signals rarely line up exactly with a single frequency bin, which can result in some ugly behavior unless a window function is used. Many different window functions are available, with various strengths and weaknesses.

For the BB60, swept modes default to a flat top window, which offers excellent amplitude flatness and therefore very little scalloping loss, in exchange for a wider resolution bandwidth and longer processing time. Most RBWs used by the BB60 are from flat top windows, so scalloping loss is negligible.

In real-time mode a Nuttall window function is used, which has a narrower bandwidth to reduce processing time and level out impulse response. However, when a signal falls halfway between two “bins,” the energy is split between adjacent bins such that the reported “peak” amplitude may be lower by as much as 0.8 dB.

To get an accurate CW reading using “Marker peak”, flat top RBW shape in swept mode is recommended.

In either mode, the “channel power” utility, which integrates the power across any channel bandwidth you specify, also eliminates this scalloping loss, giving you a full accuracy amplitude reading even in real-time mode.

3.4 Dynamic Range

Dynamic range has many definitions, but one common definition in spectrum analysis is intermodulation-free dynamic range (IMFDR), 2/3(TOI – DANL), normalized to a 1 Hz RBW.

At 1 GHz, -10 dBm reference level, the TOI is typically +15 dBm, and DANL is typically -141 dBm (1 Hz RBW). Dynamic range, 2/3 (TOI – DANL) = 104 dB.

At any reference level, 0 dBm or below, the front end attenuator will be the sole source of gain control, and as reference level changes, both TOI and DANL change by roughly the same amount, keeping dynamic range fairly constant. At a +10 dBm reference level, the RF gain cannot be set for optimum dynamic range, and this number will be a few dB lower.

3.5 Protecting the BB60D RF Input

The BB60D's input attenuator and front end switches can be damaged by ESD above 1.5 kV HBM, and have a damage level just above +20 dBm peak (not RMS). Some common events which may lead to front end damage include:

1) Applying more than +20 dBm peak power, such as an antenna exposed to a radar pulse.

2) ESD from a passive antenna, either from discharge to an antenna element, or from connecting a large antenna or cable which has built up a static charge.

3) Long term exposure to frequencies below 1 MHz and above +12 dBm may cause attenuator damage

For any application which may expose the BB60D to front end damage, including connecting to antennas or power amplifiers, a coaxial limiter is required to protect the input.

A limiter will protect against overpowering the input, typically raising the damage level above 2 watts, as well as offering significant protection against ESD.

Generally, the performance at low input signal levels is just the insertion loss of the limiter, but at high signal levels there will be some nonlinearity and the resulting intermodulation products. A typical limiter will have an IP3 around +30 dBm, so for input signals below -10 dBm there should be little to no effect on linearity.

4 Troubleshooting

If you experience a problem with your Signal Hound, please try these troubleshooting techniques before contacting us.

4.1 Unable to Find or Open the Device

Ensure the device is plugged in and the LED is on. If it is not, unplug then plug in the device until it mates completely. Once the LED turns on, use the *File* menu to try to connect the device again.

4.1.1 A Power Cycle Does Not Fix the Problem

If a power cycle still does not allow you to connect the device, it is possible the device drivers were not successfully installed. See the **Driver Installation** section for information about the BB60 drivers.

4.2 The Device is Not Valid

In the event the device ceases to operate or becomes corrupted, the application might tell you the device does not appear to be valid. Before contacting us, attempt to power cycle the device and restart your computer to ensure nothing else is causing this issue. If the issue persists, please contact us.

5 Calibration and Adjustment

Calibration software is available for the BB60D at no charge, but requires specialized equipment normally only found in calibration labs. Contact Signal Hound for more information regarding calibration software and required equipment, or to schedule a calibration.

6 BB60D Preliminary Specifications

The following preliminary specifications are based on being in the Preset condition, using internal time base, video processing set for average and power, plus VBW, sweep, gain, and attenuation in the default auto mode. Preliminary specifications are subject to change without notice.

Frequency range	9 kHz to 6 GHz
Streaming Digitized I/Q	4 kHz to 27 MHz of selectable IF bandwidth that is amplitude corrected
Resolution Bandwidths (RBW)	1 Hz to 10 MHz
Internal Timebase Accuracy	±1 ppm per year
Sweep Speed (RBW ≥30 kHz)	24 GHz/sec
Amplitude (RBW ≤100 kHz)	Range: +10dBm to Displayed Average Noise Level (DANL)
	Absolute Accuracy: ±2.0 dB (Non-Native(Flattop) RBWs) +2.0 dB/-2.6 dB (Native(Nuttall) RBW's – faster DSP)
RF Input VSWR at tuned frequency	≤ 3.0:1 typical (<10 dB attenuation)

≤ 1.5:1 typical (≥10dB attenuation)

LO Leakage at RF Input	-80dBm

Displayed Average Noise Level (DANL)*

Input Frequency Range	**dBm/Hz**
9 kHz to 500 kHz	-140
500 kHz to 30 MHz	-154
30 MHz to 6 GHz	-158 + 1.1dB/GHz

Residual Responses*	-120 dBm (ref Level ≤ -30dBm, 0dB Attenuation)
Spurious Mixer Responses*	-50dBc (any ref level from 0dBm to -30dBm, in 5dB increments, input signal 10dB below ref level, and ≤30kHz RBW)
IP2 *	30-130 MHz: +36 dBm (ref Level = -10dBm) <30 MHz, >130 MHz: +50 dBm (ref Level = -10dBm)
IP3 *	+10 dBm (ref Level = -10dBm)

SSB Phase Noise at 1GHz Center Frequency*

Offset Frequency	**dBc/Hz**
100Hz	-80
1kHz	-90
10kHz	-93
100kHz	-97
1MHz	-117

Synchronization (≤ 20MHz IBW)	1 PPS GPS input port enables ± 50ns time-stamping
Operating Temperature	32°F to 149°F (0°C to +65°C) Standard; -40°F to 149°F (-40°C to +65°C) for Option-1
Weight	Net, 1.10 lbs. (0.50 kg)

Size	8.63" x 3.19" x 1.19" (219mm x 81mm x 30mm)
Power	(1) USB 3.0 port and (1) adjacent USB 2.0 or USB 3.0 port
	Approx. 6 watts active, 1 watt idle.
Control and Communication	USB 3.0 serial bus
Option 10 Input Voltage	4.75V – 5.25V, <200 mVpp ripple.

**DANL, Residual Responses, Spurious Mixer Responses, and Phase Noise specifications apply only at 20°C to 25°C.*

*** IP2 and IP3 typical performance specifications can be found in the* ***Appendix: Typical Performance Characteristics of the BB60D.***

7 Warranty and Disclaimer

7.1 Warranty

The information contained in this manual is subject to change without notice. Signal Hound makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose. Signal Hound shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. This Signal Hound product has a warranty against defects in material and workmanship for a period of two years from date of shipment. During the warranty period, Signal Hound will, at its option, either repair or replace products that prove to be defective.

7.2 Warranty Service

For warranty service or repair, this product must be returned to Signal Hound. The Buyer shall pay shipping charges to Signal Hound and Signal Hound shall pay UPS Ground, or equivalent, shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes, to and from Signal Hound, for products returned from another country.

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The remedies provided herein are the Buyer's sole and exclusive remedies. Signal Hound shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

7.5 Certification

Signal Hound certifies that, at the time of shipment, this product conformed to its published specifications.

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8 Appendix

8.1 Typical Performance Characteristics of the BB60D

Below are characteristics of the BB60D which have shown to be typical. These are not hard specifications but show the typical performance in a few aspects not covered in our official specs.

The official BB60D device specifications can be found in this document under the section titled **BB60D Specifications**.

8.1.1 Third Order Intercept (TOI)

	Typical IIP3 at Specified Reference Level (dBm) Gain and Atten = AUTO			
Freq(GHz)	**R.L. = -30**	**-20**	**-10**	**0**
1	-4.5	5.5	15.5	25.5
2.5	-4.8	5.2	15.2	25.2
4	-4.0	6.0	16.0	26.0
5.5	-1.0	9.0	19.0	29.0

8.1.2 Second Order Intercept

	Typical IIP2 at Specified Reference Level (dBm) Gain and Atten = AUTO			
Freq(GHz)	**R.L. = -30**	**-20**	**-10**	**0**
1	45.7	55.7	65.7	75.7
2.5	46.2	56.2	66.2	76.2
4	43.1	53.1	63.1	73.1
5.5	42.0	52.0	62.0	72.0

8.1.3 Typical Displayed Average Noise Level (-30 dBm R.L.)