1. Overview of Audio and Video Apps for iOS

A number of Apps record stereo sound on iOS devices using SonicPresence's SP15C Spatial Microphone. This manual compares each App's functions for making an original Audio Recording and explains our testing methods. Many of the Apps have additional signal processing functions (editing, equalization, dynamics) that are not addressed here. For details about these functions, please consult each App's Instruction Manual (sonicpresence.com/resources). We give you the URL for each developer's website where you can find additional information.

Each App is the creation of an individual developer. There are no industry standards for audio recording on mobile devices, so you'll find the User Interface (UI) as well as the signal processing vary widely between Apps. Some Apps will hijack control of Sonic's internal Digital Signal Processing (DSP) in unexpected ways. We'll try to point these out in the following descriptions of each App.

One function we find very handy is the "lock screen" button. It's the button on the top right edge of your iPhone also called the Power Button. When any of these Audio Apps are running, pressing "lock screen" will lock all controls and shut off the screen. The Audio App keeps running. You can put the phone in your pocket and not have to worry about accidently hitting a wrong button. To exit "lock screen" mode, hit the "Home" button. That will return you to the Audio App screen.

The International standard for testing microphone output level is 94dB Sound Pressure Level (SPL), which is equal to a pressure of 1 Pascal. That is loud! When we do our final testing of the SonicPresence® Spatial Microphones however, we do it at an even higher level of 120 dB SPL. That is as loud as it gets at a heavily amplified Rock Concert. Our reason for this choice is to guarantee you will not have any distortion caused by the microphone. If there is distortion in your recording, it's because the App's Mic Volume (Input Level) is not set correctly.

You set the Mic Volume by watching the colors displayed on the meter scale. You want to set the Volume, so the meters show green most of the time, yellow some of the time, and red only once in a while when the sound reaches its peak loudness.

2. Digital Audio File Formats Table

Quality	Ultra	High	CD	Good	Fair
Sampling	96kHz	48kHz	44.1kHz	44.1kHz	44.1kHz
Word Size	24bit	24bit	16bit	16bit	16bit
Format	PCM	PCM	PCM	AAC	MP3
Bit Rate	4,608kbps	2,304kbps	1,411kbps	320kbps	128kbps

3. iOS App Comparison Table

		Apple iOS Audio Recording Apps					Video Apps with USB Sound			
		Motiv	**Twisted Wave**	**Røde**	**Garage Band**	**VR Pro 7**	**Apple Camera**	**Motiv Video**	**ProMovie**	**Filmic Pro**
Operation		Intermediate	Advanced	Intermediate	Intermediate	Intermediate	Basic	Intermediate	Intermediate	Advanced
USB Device Indicator		Y	N	N	Y	Y	N	Y	Y	Y
Mic Volume Control		Y	Y	Y	Y	Y	N	Y	Y	N
Meters										
	Visibility	excellent	excellent	small	good	good	NA	excellent	fair	good
	Calibrated	Y	Y	N	Y	Y	NA	Y	N	N
	Accuracy	excellent	excellent	good	good	poor	NA	excellent	good	good
	PPM	Y	Y	Y	N	Y	Y	Y	Y	Y
	VU	N	N	Y	Y	Y	N	N	N	N
Sampling Frequencies										
	96kHz	N	Y	N	N	Y	N	N	N	Y
	48kHz	Y	Y	Y	N	Y	N	Y	Y	Y
	44.1kHz	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Others	N	Y	Y	N	Y	N	Y	N	N
Word Size in bits		24	24/32	24	16	16/24	16	16	16	16
Transport Controls		Medium	Small	Large	Small	Large	Small	Small	Small	Small
Timecode Display		Y	Y	Y	Ruler	Y	N	Y	Y	Y
Digital File Types										
	WAV/PCM	Y	Y	Y	N	Y	N	Y	Y	Y
	AAC	Y	Y	Y	N	Y	Y	Y	Y	Y
	MP3		Y	Y	N	Y	N		N	N
	Others		Y	Y	AIFF	Y	N		N	N
File Export to Cloud		Y	Y	Y		Y	Y	Y	Y	Y
Waveform Display		Y	Y	Y	Y	N	N	Y	N	N

4. Dynamic Range

Our basic design concept for the SP15C was to develop a sound recording device which simulates human hearing as closely as possible. That means it must be capable of operating over an enormous dynamic range

without a level adjustment and without distortion. Basically, a "point and shoot" microphone anyone can use to record sound the way they hear it.

First, we determine what's the maximum Sound Pressure Level (SPL) we can expect. Tests with musical groups, rock bands, orchestras and in live clubs revealed peaks up to 114dBSPL are common. We decided to add an extra 6dB of headroom and set 0dB Full Scale equal to 120dB SPL. Looking at the figure below you can observe that sound at this level is so painfully loud that listening to it is unbearable. This is the point at which our level meter scale registers 100% or 0dB or the maximum number of bits for our digital converter.

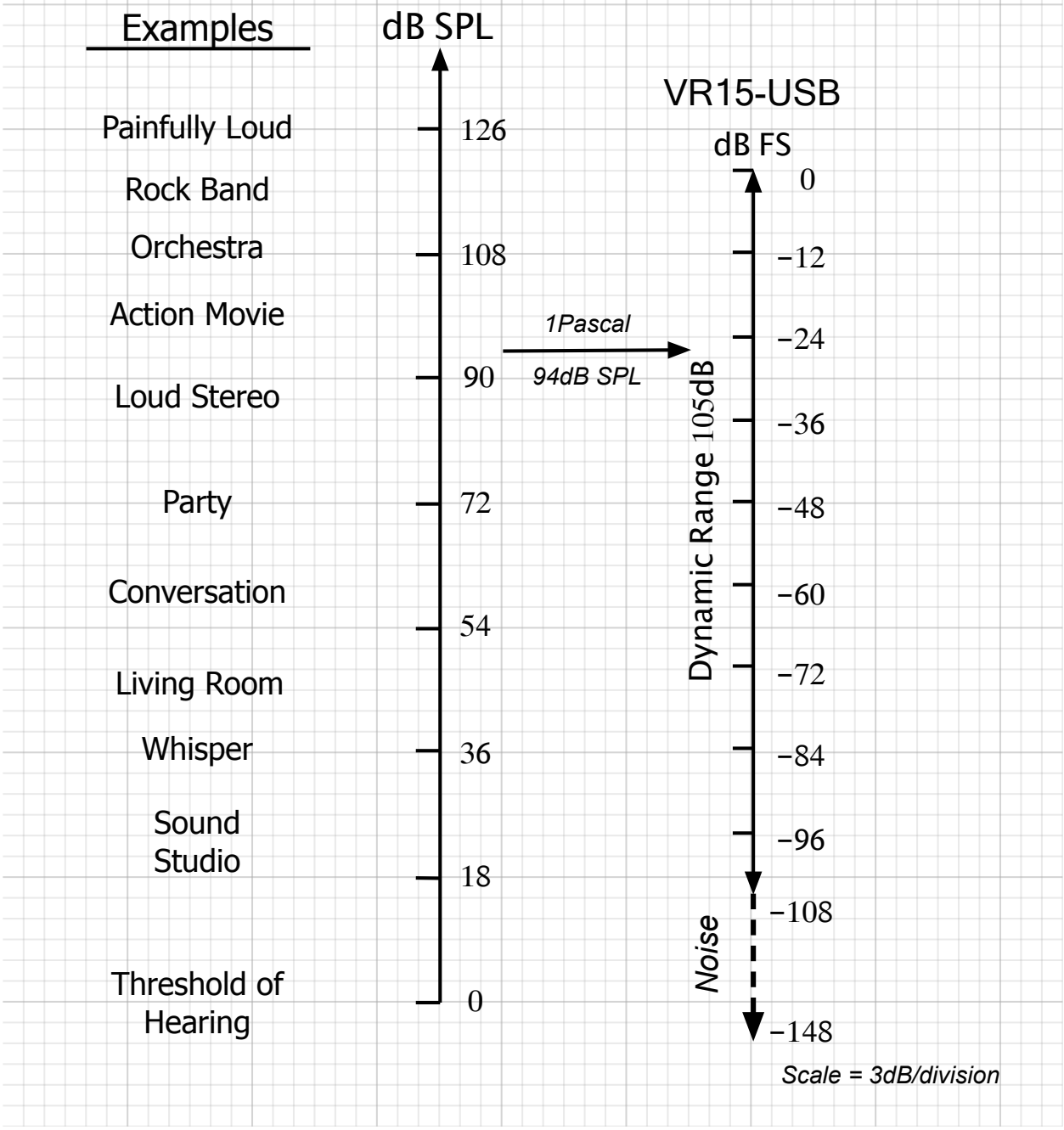
Today we have hardware capable of processing 24-bit audio samples at bit rates of 96kHz or even higher. That's means it's possible to handle a dynamic range of 144dB (ratio of 16,000,000:1) and a frequency range of up to 40kHz (12 octaves). These are greater than the range of human hearing according to what we know from current scientific research.

The limits of dynamic range for audio hardware are determined by the maximum amplitude before the onset of distortion on the loud side and the amplitude of the noise floor on the quiet side. If we dimension our signal levels so the quiet side is equal to 0dBSPL, which is the threshold of human hearing, then the maximum level of a 24-bit signal chain on the loud side is 144dBSPL. That's well beyond the level of human pain and will permanently damage our ear's hearing.

What we've described so far is the theoretical range of a 24-bit system. On the practical side, however, there are some limitations. The conversion of real-world analog signals to digital samples is not a perfect process. This is particularly so on the quite side where electronic noise and manufacturing imperfections creep into the precision of the analog to digital conversion process. Today's technology achieves a precision of 20-bits on the high side while more typically achieving 16 to 18-bits in commercial devices. Still, this is an enormous dynamic range, which can exceed 100dB or a ratio of 1:100,000.

The SP15C microphone design incorporates a 24-bit analog converter. We've chosen 120dBSPL as the level at which we generate a full scale 24-bit digital sample. Our experience with live music proves this is sufficient for recording extremely loud concert performances of amplified bands and very large orchestras.
On the quiet side, our experience shows dynamic range is limited by the noise of the acoustic environment. In the real world we live in, acoustic noise levels below 40dBSPL are rare. The very quietest recording studios and concert halls can sometimes achieve 20dBSPL, but that's without people. Our experience with live recordings shows that 100dB dynamic range is what's practically achievable.

Audio Dynamic Range



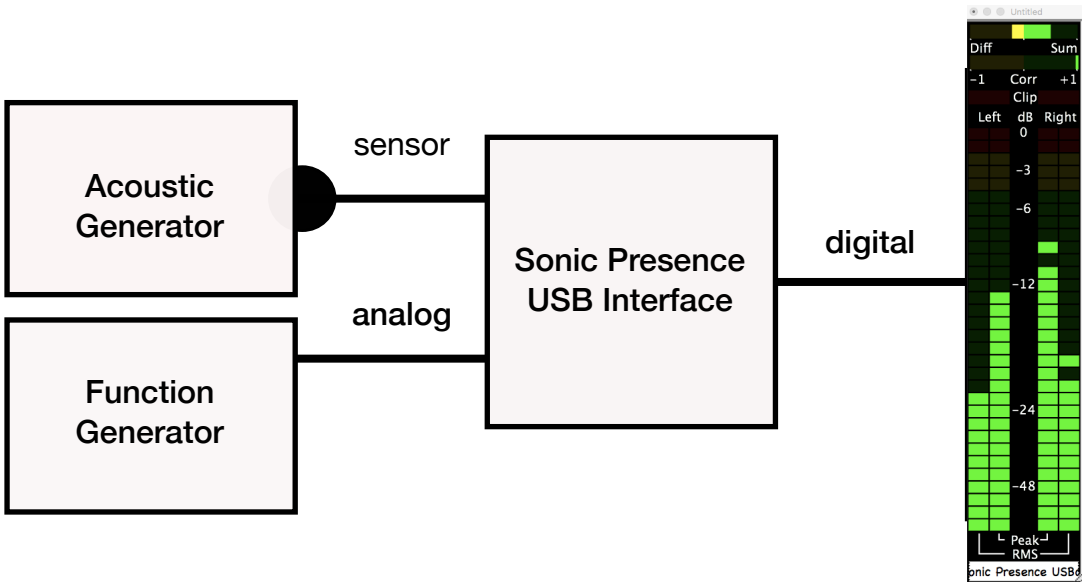
5. Testing Methods

SonicPresence's Level Test Setup and Measurement Procedure

In order to accurately measure signal levels and determine the precision of meter readings you must use calibrated test signals. For our acoustic tests we used an ANSI S1.40 - 1984 calibrated sound generator. It produces a 1kHz sine wave signal, which is switchable between 114dB and 94dB SPL (Sound Pressure Level). The International standard for testing microphones is 94dB, which is equal to a pressure of 1 Pascal. When we do our final testing of the SonicPresence® Spatial Microphones, we set the output level to equal 0dB Full Scale at 124 dB SPL. That is as loud as it gets at a heavily amplified Rock Concert. This choice of signal level guarantees there will be no distortion caused by the microphone. If there is distortion in your recording, it's because the Input Gain is set Incorrectly.

We made our test measurements by inserting the SonicPresence® sensors directly into the sound generator's calibrated sound chamber. For our digital measurements, we used a 1kHz function generator with an output signal amplitude that we could adjust in steps of 0.1 millivolt. We then injected that signal into the analog sensor input of the Sonic USB Interface. (CAUTION: You should not try this at home. You could permanently damage the unit.)

For both of these measurements, the SonicPresence's digital output signal is then plugged into the USB port of the test device to determine the digital signal levels. We used three different measurement Apps to insure the accuracy of our digital test signal. The first is the ProLevel Meter App from Katasura Shareware. The second is Apple's Logic Pro X App and the third App is MusicScope from XiVero. All of these Apps are running on a MacBook Pro computer under OSX.

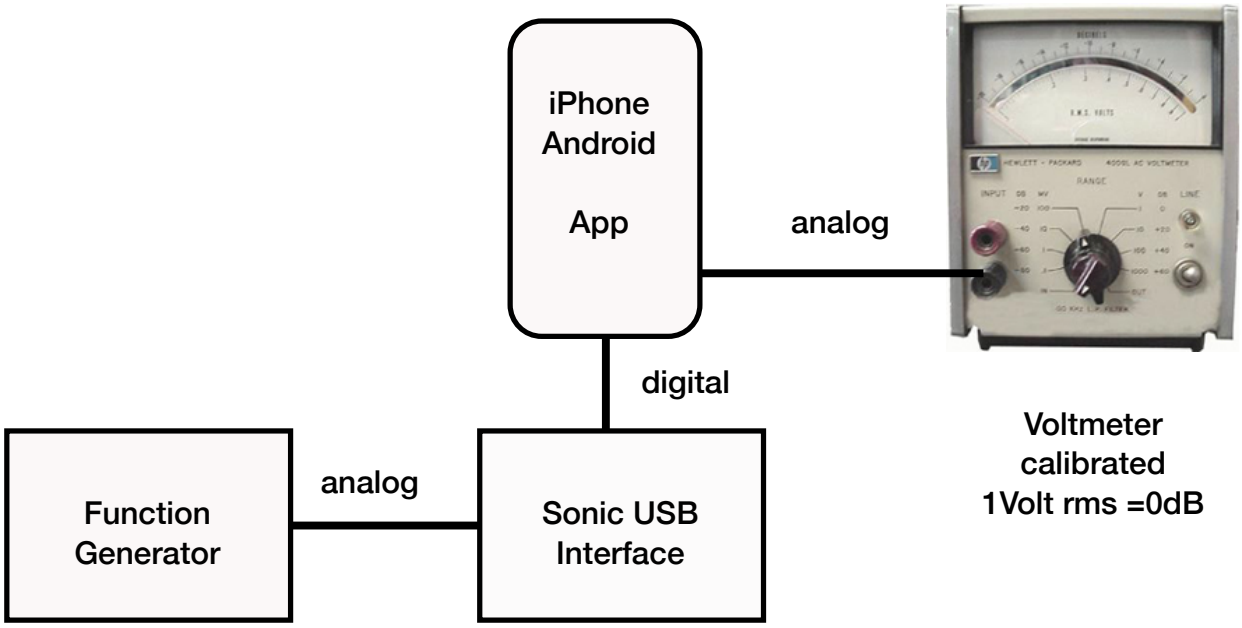


This Reference Table shows the output level of the signal generator in millivolts in the left column. We calculate the level in dB in the next column to the right. The next three columns are the actual readings in dB shown on the scale of the three measuring Apps.

Reference Table				
generator	calculate	ProLevel	Logic	MusicScope
mV rms	dB	dB	dB	dB
80	0	0	0	0
55	-3	-3	-3.5	-3
40	-6	-6	-6	-6
20	-12	-12	-12	-12
10	-18	-18	-18	-18
5	-24	-24	-24	-24

We measure the signal levels and meter indications of each App using our reference test signals. The digital output of the SonicPresence® Interface feeds directly into the phone's USB port.

We record a test file for each App noting the Input Level meter readings for each step of the test signals. Then we played back the file with the App and note the meter readings on the screen and measure the analog output levels. We do this by connecting a calibrated dB meter to the phone's output. In most cases the output is the phone's headphone jack. However, there are some Apps and phones that have no headphone output. In those cases, we used an AudioQuest DragonFly Digital to Analog Converter (DAC) plugged into the phone's USB output. The phone's volume control was set to maximum to insure output amplitude consistency for all of these measurements.



This table shows our test results for the Røde App. Note the Apps meter is not calibrated, so we indicate the playback level by noting the lit LEDs: red, yellow and green.

Now you can see how the Apps meter readings correspond to the digital input signal level and the phone's analog output. We're looking for linearity, meaning a 50% decrease in the generator mV signal level should correspond to a 6dB decrease in the output level. You might notice some slight discrepancies at the top of the scale as the level approaches 0dB. That's the reason you want to keep your maximum recordings levels below -6dB or lower to avoid any distortion. Don't worry about noise as you would with analog recording. This is digital. The noise floor is more than 90dB below your recording level. For practical purposes, we can say there is no noise!

Røde							
scale	green	green	green	green	yellow	red	red
scale marking	na	na	na	na	na	na	na
generator mV rms	5	10	13	20	50	80	160
calculated level in dB	-30.1	-24.1	-21.8	-18.1	-10.1	-6.0	0
PB level (analog)	-32	-24	-18	na	-12	-8	-4
reference acoustic level			94dB SPL				114dB SPL