Ham Audio Analysis

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Warning, before spending any money on the cool tools shown in this article, please understand that I ended up feeling only 1 was truly relevant for Joe Ham Testing. You dont need to spend a dime really to try my final two tests I decided on using.

While the article, due to its exploratory learn as we go nature, offers opinions at various points on the Anan 100D and Elecraft KX3, there is no formal opinion or conclusion offered at the end of the day. I plan on doing my own testing and perhaps then once I have had some quiet dedicated time I will offer an opinion.

If you have been following my reviews, I have been striving to find better ways to Joe Ham compare radios.

What do I mean? Well, trust me when I say it's not assault on anyone's intelligence and this is not an attack on all the wonderful testing efforts we already have out there. It's also not a campaign telling you to ignore those efforts and all their hard work.

What it is about is what we, some of the average hams, operating our radios can see an actually experience in our shacks without a lot of fancy test equipment.

I have been on a quest for an easy meaningful visual reference we can use to compare two radios in a ham shack with out the need for thousands of dollars of test equipment. Lets say the budget here is sub $100, the lower we make it the better as a base assumption.

I have been playing with all kinds of free and or inexpensive tools (software, some hardware) towards finding something that I can reply on for testing and then share with you the readers.

The concept we are exploring here is whether we can effectively use a radios audio output as a means of easily comparing radios and creating tangible visual references to support the comparisons. This article therefor explores audio, audio analysis tools and possible use and techniques of those tools to derive our comparison. As such we need to learn about audio if we dont already have that background.

Part 1
Let's learn a little bit about audio and some relationships to ham radio to set the table.
http://en.wikipedia.org/wiki/Audio_bit_depth - ***snipit below***

So if we go by the wiki info below and consider that most SSB output is less than 3.2K wide, analysis needs can be seemingly quite low for Joe Ham to play with all this.
FROM [http://wiki.audacityteam.org/index.php?title=Sample_Rates]

----------------- SNIP ----------------------------

Bandwidth

Sample rate is the number of samples of audio carried per second, measured in Hz or kHz (one kHz being 1 000 Hz). For example, 44 100 samples per second can be expressed as either 44 100 Hz, or 44.1 kHz.

Bandwidth is the difference between the highest and lowest frequencies carried in an audio stream. The sample rate of playback or recording determines the maximum audio frequency that can be reproduced, as shown below.

Sample Rate (kHz)	**Maximum Frequency** (kHz)
8	3.6
11.025	5
22.05	10
32	14.5
44	20
48	21.8
64	29.1
88.2	40
96	43.6

For audio work, bandwidth is normally about 20 Hz less than the highest recorded frequency, so for practical purposes they can be treated as the same thing. Hence the terms are used interchangeably here. The term bandwidth may be applied to the frequency content of an audio signal stream, or the frequency ability of audio hardware or software.

Which Sample Rate To Use

44.1 kHz / 20 kHz

44.1 kHz is the sampling rate of audio CDs giving a 20 kHz maximum frequency. 20 kHz is the highest frequency generally audible by humans, so making 44.1 kHz the logical choice for most audio material. High quality tape decks using metal tape, and medium quality LP equipment can reproduce 20 kHz (higher for top quality LP equipment, though some of this is harmonic distortion inherent in the medium). Note that the upper limit of human hearing falls rapidly with age. While people in their teens can hear 20 kHz, many older people cannot hear above 14.5kHz.

Reduced Bandwidth Recording

Audio may be recorded at below 20kHz bandwidth for a few reasons:

- To reduce file size
- To reduce CPU usage
- Because the source material itself is of less than 20kHz bandwidth.

A lower sampling rate can also be used to remove the highest frequency hiss present in a noisy signal. While in theory there is no loss of quality as long as the bandwidth of the sample rate stays above the audio signal bandwidth, in practice one often does not know exactly what the signal bandwidth is. So for most purposes, a better option is to use noise gating for hiss reduction, which has much more effect and is less likely to compromise the recorded signal. The Audacity 'noise removal' filter is a multi-channel noise gate.

----------------- END SNIP ------------------------

If we are doing some shortwave listening on AM I have seldom seen anything wider than 10K actual width. So the point here is we can use a PC with a decent soundcard to adequately test todays current crop of ham radio audio. Your PC if you have one already has a sound card, therefore, cost is $0.

One thing that is also very important to understand in all this is that while a signal might be 20K wide on an SDR, it does not mean we will get 20K wide audio.

The human voice for example occupies about 8K of range from 100hz to 8khz. This is covered a little more in the next article in this series. Said another way, even if we record 20k wide SSB we may still only see 8k on a spectrum analyzer. Remember that AM 20K Wide is really 10K wide doubled as well. Bottom line here though we are talking signal bandwidth verses audio bandwidth, the two being different.

This will make more sense as we move forward, however, it's important to mention now that we have a much greater chance when listening to music to see tones across the full range of the audio spectrum. Interestingly enough, different kinds of noise and hissing sounds sit in the space above 4k as well.

Part 2

Let’s talk about the hardware, tools and concepts next so we can walk through this and make a logical and progressive presentation.

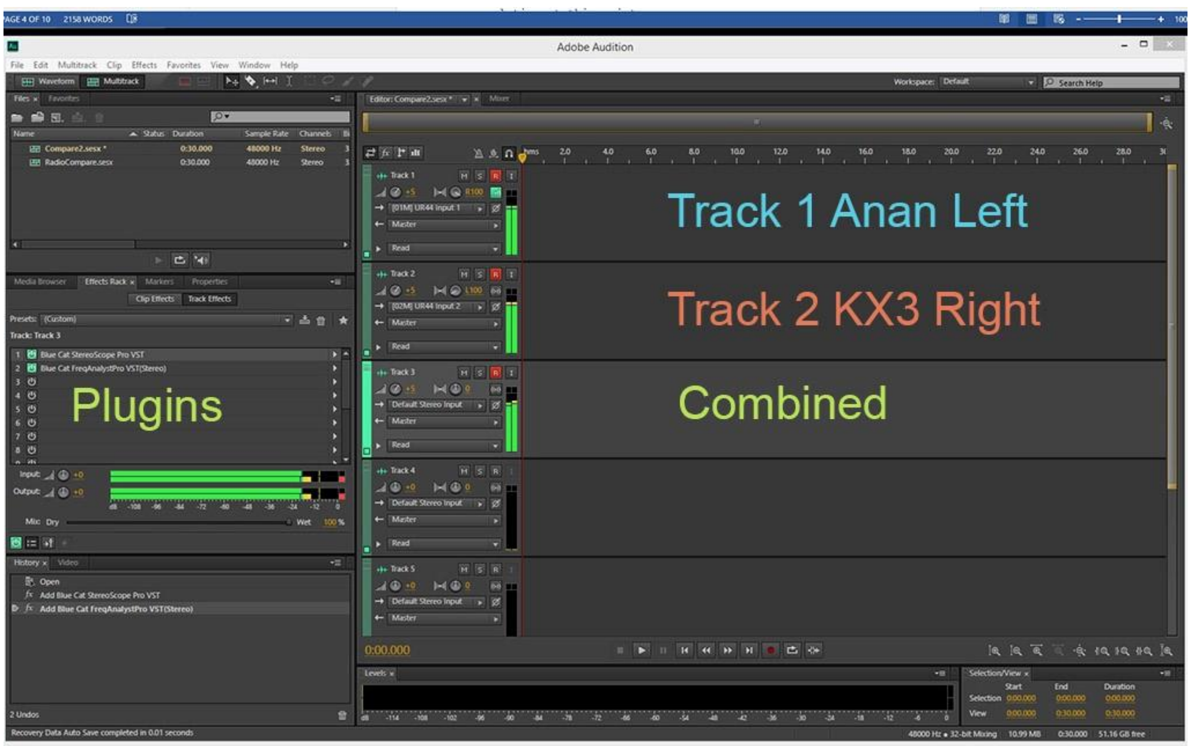
For the tests I am using a Steinberg UR44 external USB 2.0 based Interface with 4 XLR inputs and a number of outputs. I am using a little set of iHome speakers of the interface out of the phones jack which allows me to easy control volume. Again, you can just use your soundcard and a simple test setup picture appears near the bottom of this article.

Radios hooked in via the left side first two SLR jacks

These inputs are fed into a program/software called a DAW. DAW stands for *Digital Audio Workstation* and is the backbone software for recording artists. You can read more about DAWs at this Wiki Entry. http://en.wikipedia.org/wiki/Digital_audio_workstation

The DAW allows me to create a Left and Right Audio track, the Anan being on the left and the KX3 on the right. A third track combines the two into left right channels. One might see this as a stereo audio single, however, I have deliberately went through this effort to get the two mono channels on to one quasi stereo channel so we can use plugin software (VST Plugins in this case) to view and analyze and compare the signals.

After experimenting with a bitscope, PC Ocilloscope and True RTA on VAC Lines, I started using Adobe Audition to manage the inputs and host the VST Plugins for the testing and research I am doing into this area in comparing radio audio. You can download a trial DAW for free and not pay anything. Also, Reaper at $69 would be more than adequet long term if you are interested in licensing a DAW. To play, we are still at $0.



The DAW – Adobe Audition running on Hamzilla

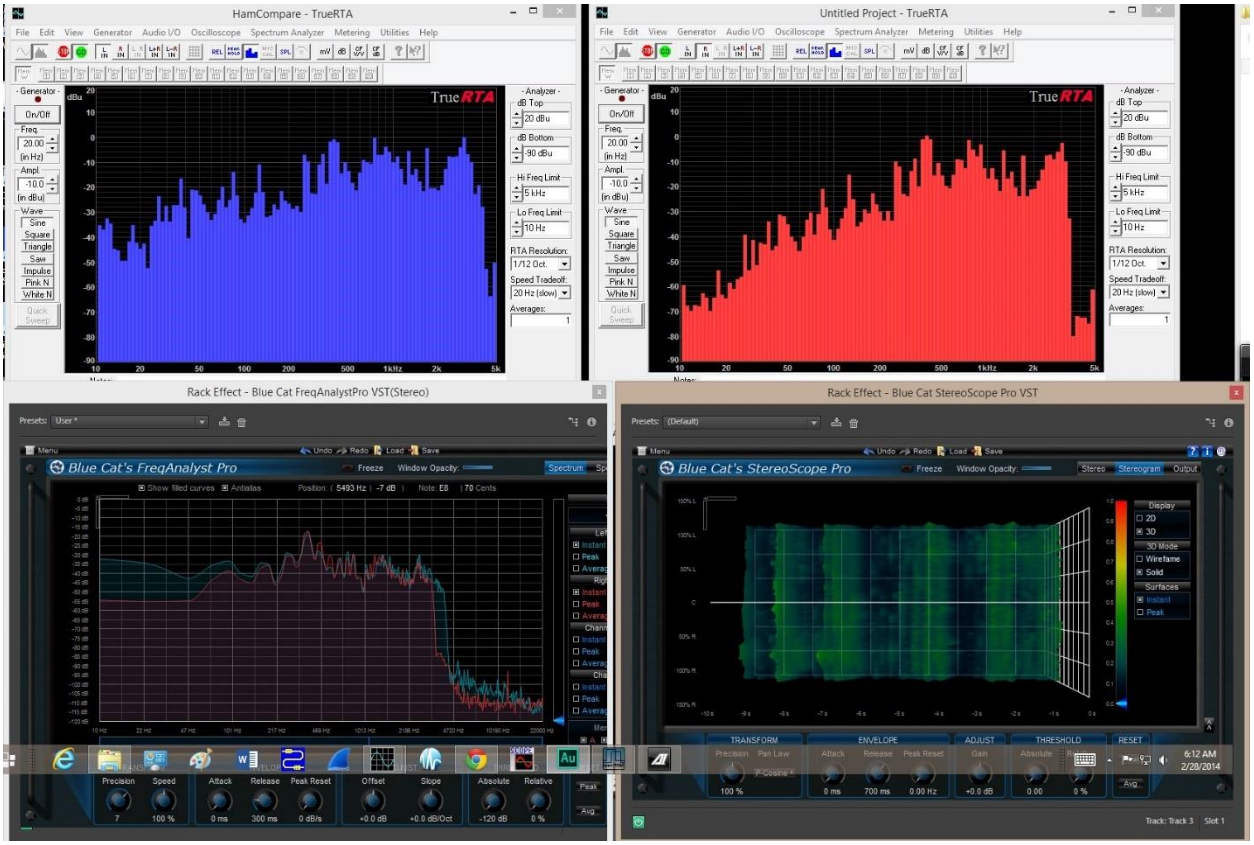
Two Spectrum Analyzer plugins I have been playing with by Blue Cat Software

We'll talk more about these plugins and why I am interested in them for our testing later in this article.

Just to keep you plugged in though, the blue signal on the left spectrum view is the Anan and the Red is the KX3. You can see in this view that their capture range of the frequency is very similar as is their tonal makeup where they nearly mirror each other. Not really unexpected since they are receiving the same signal. Remember the left side is the bass and you can see that the audio is heavy with it on the spectrum analyzer and the highs are on the right which drop off just short of 5K.

On the right we see a heat map view of lows, mids and highs top and bottom of the two signals compared to each other with the Anan on top and the KX3 on the bottom. This allows us to see the tonal intensity in the lows, mids and highs and here too you can see they look similar. Thus far I have not found these views to provide much value over a normal spectral view.

TrueRTA



**On the top you see TrueRTA (RED & BLUE Spectrum Displays)
In these views we can see that the KX3 lows drop off faster than the Anan's in the RTA view, Anan Blue, KX3 Red.**

In this picture we see TrueRTA, this is not a VST Plugin and is a separate program audio spectrum Analyzer and Oscilloscope software package. Using a spectrum analyzer/Oscilloscope software package you can get for $39-$99 (price range reflects options) TrueRTA I was able to also monitor left and right channels (Anan & KX3) side by side to see how they differ.

All should become more clear as we progress forward, so I ask that you stay with me as I try to lay this out in layman’s terms.

If we go back to the goal here, I am trying to develop an approach to visually and meaningfully compare radios in a layman like visual view.

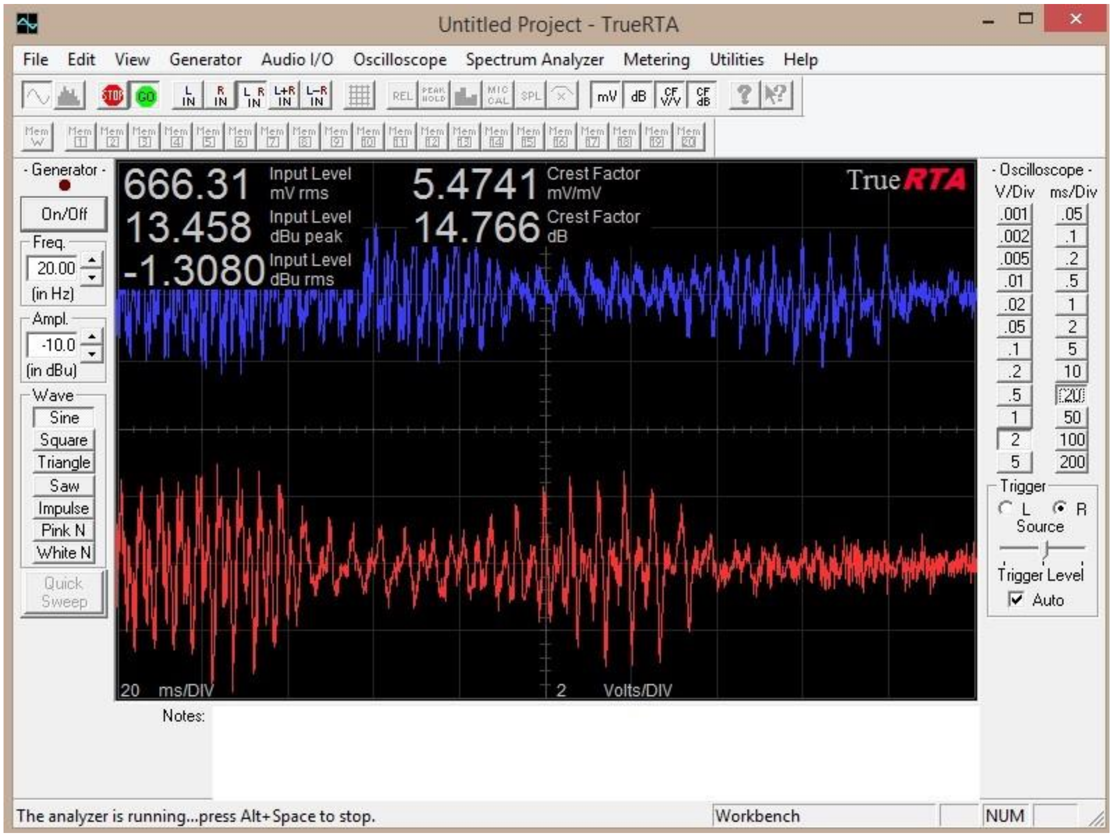
Regrettably other than using ones ears there is no super easy way for a average ham to easily compare radios. We can use an oscilloscope with a limited amount of effort using software like TrueRTA or PC Oscilloscope and easily see the signals using a normal sound card and some adapters from radio shack.

These tools if you want to buy them and get the higher end full versions can start to add up in terms of costs. There are also lots of low cost free tools as well if you want to play and other than TrueRTA which I bought the full 24 octave version, and the DAW (roughly $200 total) and the hardware which was rather expensive ($250) it doesn't take a huge budget to have fun and extend your radio with audio software. You don't have to buy most of this and again can just use your PC Soundcard to play if you want.

Many DAWs come with lots of free plugins and while some are more elegant than others, for the purpose of processing your ham radio audio you could simply use a sound card and a DAW called Reaper and then download hundreds if not thousands of VST Plugins to play with and process your audio.

An oscilloscope can easily allow us to see visually the strength and wave/envelope shape of a given audio signal. When we run two signals overlayed or side by side we can make some basic observations about the audio we are comparing.

We are limited though to a few characteristics in viewing and comparing signals. Comparing two radios for example showed that by adjusting the volume one could match the amplitudes. You can measure the total output of the signal in millivolts and you can see the shapes of the sound envelopes by varying the sweep speed on the scope.



Anan & KX3 Audio on Oscilloscope (there is latency)

Some of the issues we have to overcome in comparing SDRs, especially against traditional radios is that SDRs have latency due to the audio being processed by the PC which takes a few more milliseconds to process than a regular radio hooked to a speaker. You can see some latency here between the Anan in blue and the KX3 in red in the picture above. While sweeping on a scope one with low latency being compared to one with high latency can cause things to appear much differently visually on a scope when what is really different is the point and time each signal is appearing to you as its being swept.

One may arguably find in the end that what makes one radio test out better than another is that it has a stronger or better audio amplifier. Some may cry foul here, however, I think we need to remember here that what Joe Ham cares about is whether one radio he buys verses another actually performs better in their shack and not that their specs or theoretical aspects are better.

You can learn about oscilloscopes here if you want to understand amplitude and sweep speeds.

http://en.wikipedia.org/wiki/Oscilloscope

Let’s move on to some experiments I did to help me build up knowledge and continue forward.

Part 3
Using a spectrum analyzer/ocilloscope software package you can get, TrueRTA, I was able to observe two things. That the spectrum analyzer did in fact reflect the bandwidth that the Afedri SDR Audio was set to up to 10K. Setting the bandwidth wider did not show in the spectrum analyzer. (Why?) The Afedri may not put out a wider amount, speculation at this point. This article corrects as we experiment and learn so stand by!

Second I observed that on a standard SSB signal on 20M reducing the sample rate to 8K did not appear to change the display verses higher sampling rates.

Worthy of note is that if you are using VAC lines its possible that you may not even need physical hardware connections to some radios. You must consider then though that you may not truly comparing apples to apples. Joe Ham says to use what you would actually use while operating your radio if you try this yourself at home. IE, if you listen to your output via VAC, then monitor the VAC lines, ect.

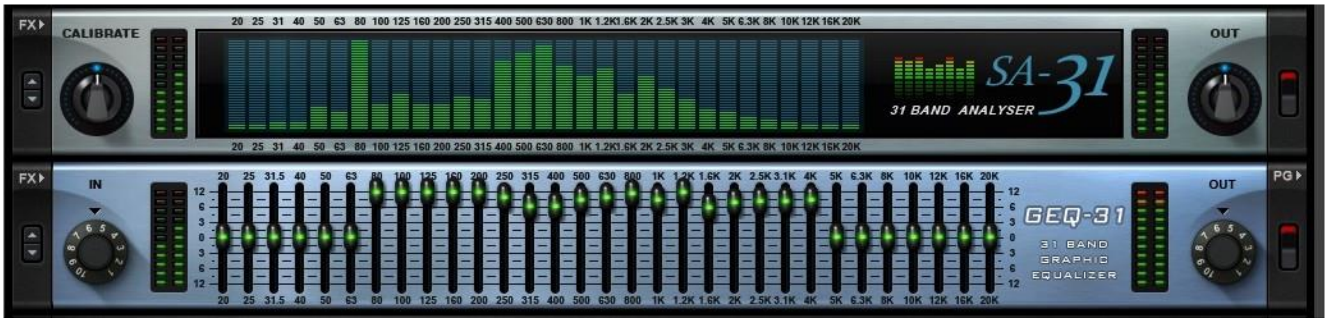
So as Joe ham, when we compare radios with a spectrum analyzer we likely won’t see anything outside a 20K range on an audio spectrum analyzer unless we were setting the filter bandwidth wider and measuring a signal that was wider and the radios capabilities allowed it. If you are saying hold on there on that 20K number, keep in mind we have SDR's that do more than HF and so FM for example can carry lots more information.

This is a good time to provide my limited knowledge on Spectrum Analyzers. In my simple terms they are good for seeing the tonality and its intensity components of an audio signal. Simply said, an audio signal has Bass, Treble and Midtones between the two. This is covered better in the Software Defined Audio Article.

On a spectrum analyzer the bass sits left and the treble components typically sit right and higher up. If you have ever played with an equalizer you may have made this correlation as well.

Here is a screenshot of a simple Spectrum Analyzer on top, and an EQ on the bottom, you can see their ranges roughly line up from left to right. You can see the settings do not match what we see on the display. IE both represent 31 bands, however the adjustments dont equate to an adjusted spectrum in this view because the spectrum is taken before the adjustments, not after.

http://en.wikipedia.org/wiki/Equalization_(audio) for more about equalizers.



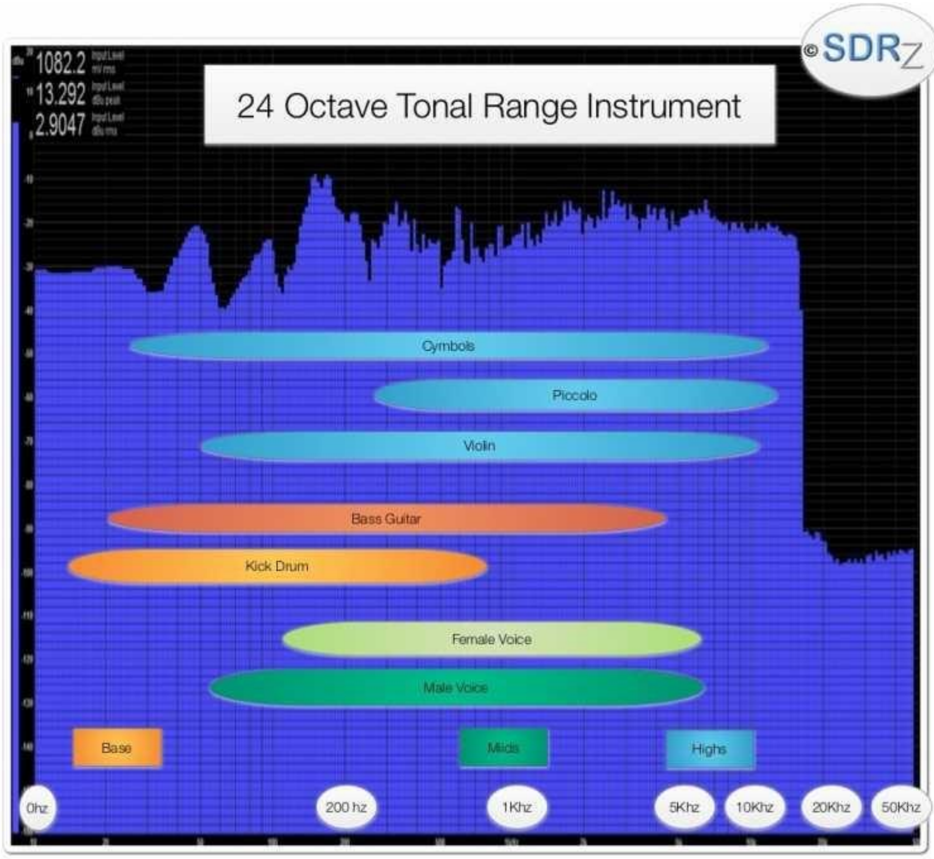
Magma FX Spectrum Analyzer and 31 Band EQ

When we run the line out or phones of a radio to a sound card I am thinking we can adequately represent it at 41K for ease and we would be over sampling in most cases.

Ham radios are not high-fidelity receivers like the stereo equipment or studio equipment some of us are used to or enjoy. And let’s face it, per the info in the wiki on audio sampling, most of us hams are not going to be hearing more than 14khz or range apparently.

When we are DXing SSB/USB/LSB/AM we are more often than not going to be working with a 2.4khz to 16Khz audio range.

So this is a screenshot of an 8bit RTR Dongle pumping the output a regular FM radio station using SDR Sharp) to a VAC line and looking at 1/24 oct on the a normal spectrum display. The larger the octave the greater resolution we see.



Note, the RTR dongle appears to be able to output a wider tonal range than the Afedri, Voice vs FM Music

In music, an **octave** (Latin: *octavus*: eighth) or **perfect octave** is the interval between one musical pitch and another with half or double its frequency. The octave relationship is a natural phenomenon that has been referred to as the "basic miracle of music", the use of which is "common in most musical systems".[1] It may be derived from the harmonic series as the interval between the first and second harmonics. http://en.wikipedia.org/wiki/Octave

The weaker the signal gets while comparing any two radios it's likely to manifest itself in a drop of volume level and or fade away if the detector and then amp loses it.

As we crank up the volume to compensate we rely more on the amp and the quality of the detection. That can manifest itself as distortion depending on the quality of the amp.

I am thinking we need to not only be able to evaluate the ability for Joe Ham to still hear the signal, but also to copy it.

If we can input a known signal into the radios we are comparing we could measure their total harmonic distortion (THD) using and audio analyzer that allows measurement of THD.

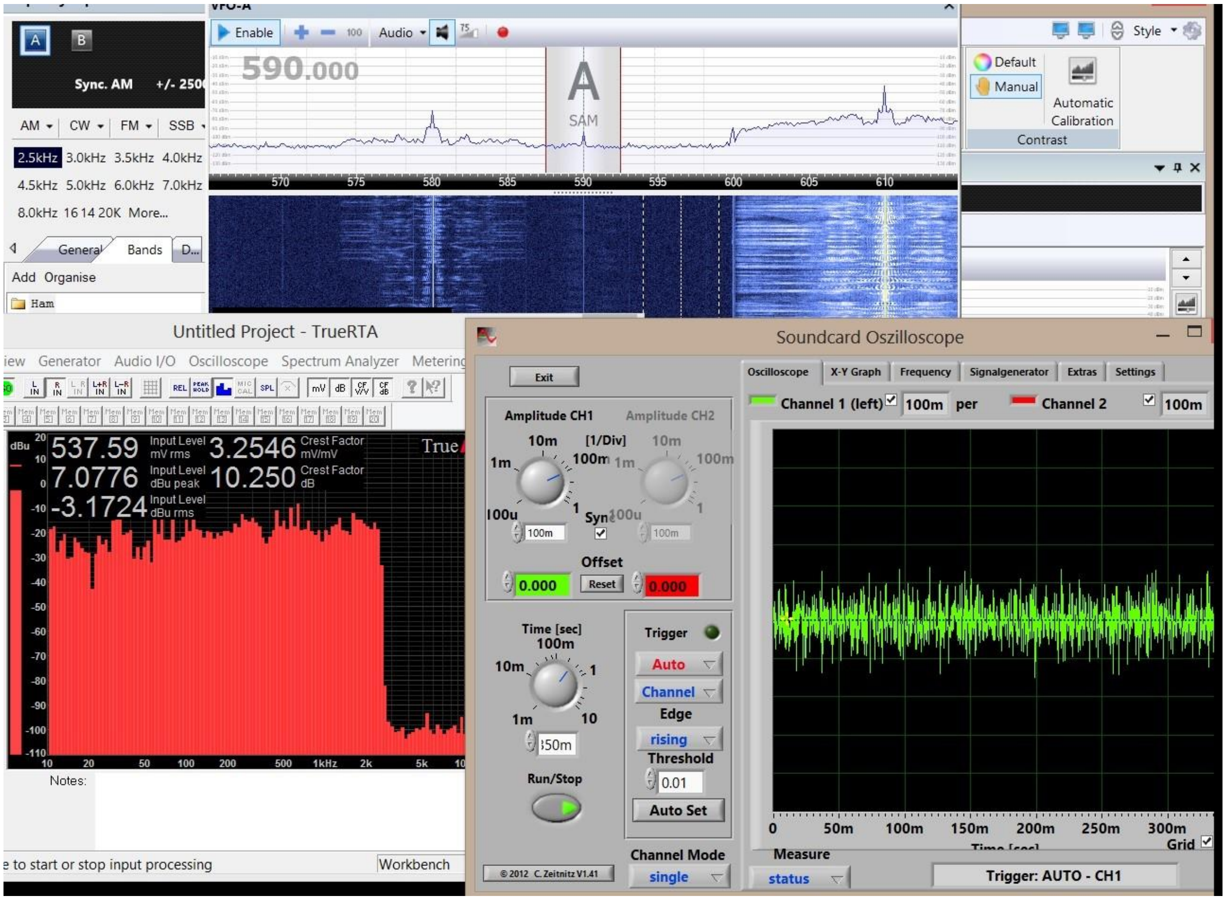
The **total harmonic distortion**, or **THD**, of a signal is a measurement of the harmonic distortion present and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency. THD is used to characterize the linearity of audio systems and the power quality of electric power systems. **Distortion factor** is a closely related term, sometimes used as a synonym. In audio systems, lower THD means the components in a loudspeaker, amplifier or microphone or other equipment produce a more accurate reproduction by reducing harmonics added by electronics and audio media. In power systems, lower THD means reduction in peak currents, heating, emissions, and core loss in motors.[1] http://en.wikipedia.org/wiki/Total_harmonic_distortion

While distortion might be relevant in cheaper radios, I don't think its as likely to pop up too much in your midrange and upper range receivers. I reserve the right to change my mind on this as I continue my exploration. For example, the KX3 speaker problem to me seems to be an audio problem and not an actual speaker problem. This might be a distortion issue and therefore may be relevant when I am able to test at that level. I hope to be able to see if I can actually flush this out using these new found audio tools.

While I think this might be interesting to some hams, it means little to Joe Ham in my opinion, because Joe Ham cares about what he can actual realize when operating the radio.

If we want to use visual tools to compare in a way that means something to Joe Ham then I think we need a very easy to understand set of visual references that equate to legible signal reception while operating a radio. More on this later in this article.

Let's look at scope and spectrum views to help better illustrate this point.



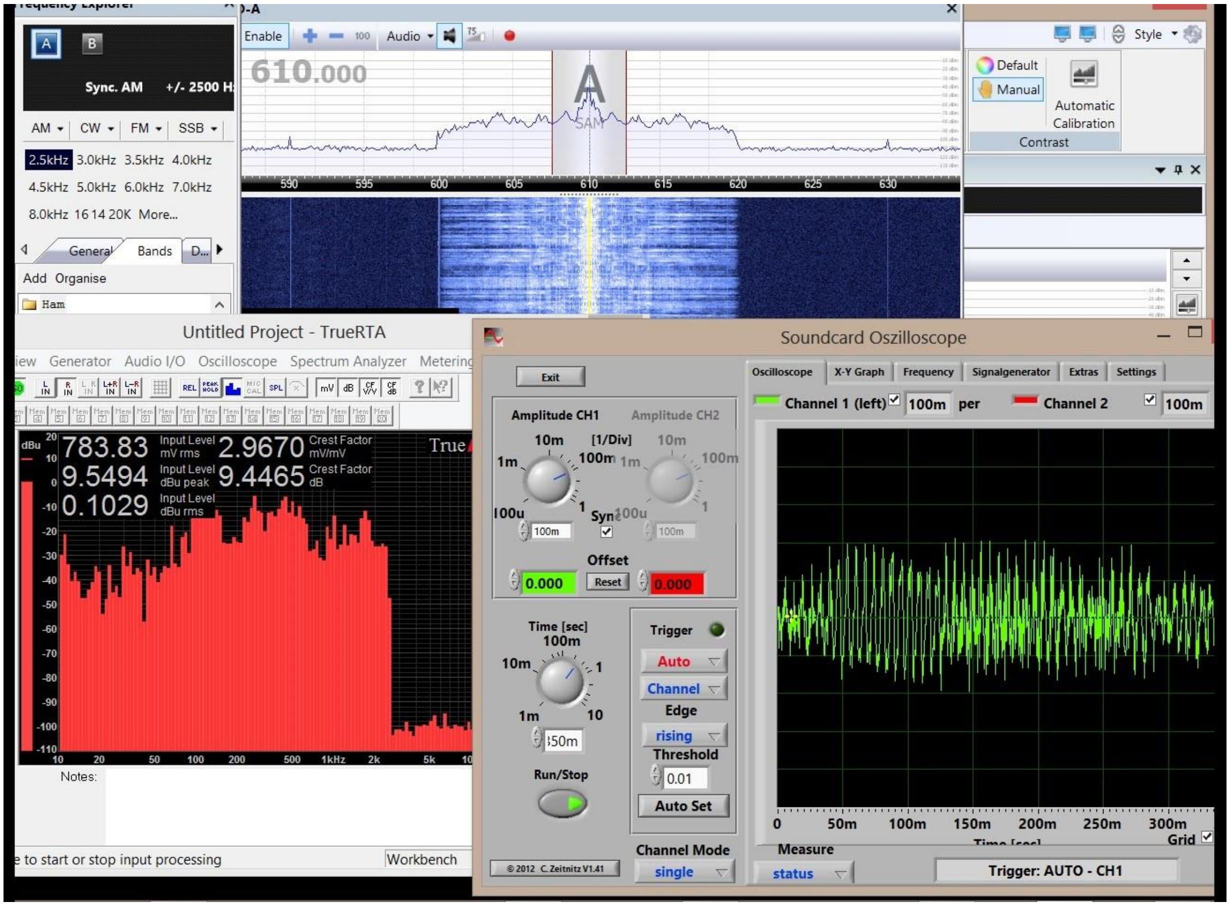
2.5K Wide Static on 590 AM to left of strong AM Broadcast Station

What you’re looking at is an AfedriNet SDR 14Bit operating in SDR-Radio 2.2 Beta, Souncard Oscilloscope and TrueRTA Spectrum Analysis Software set to 1/24 octave and a 20Khx range.

The SDR was used to monitor some broadcast AM stations and static on the same band to compare what we see when we see an signal verses static.

I think that a reference or set of references per operating mode makes the most since. Then an operator can look at the modes that interest them most and compare.

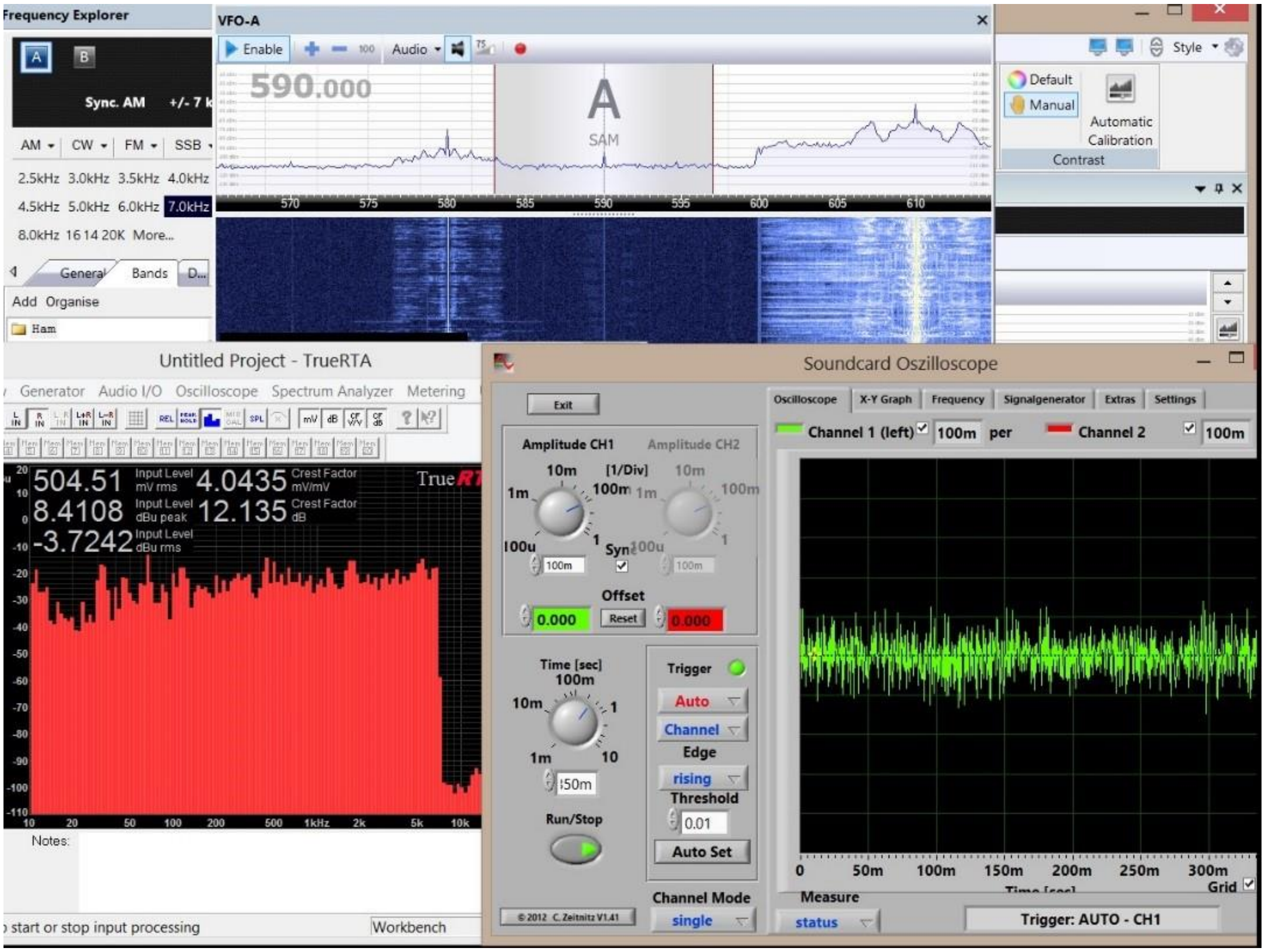
Let’s see what a Signal with audio looks like.



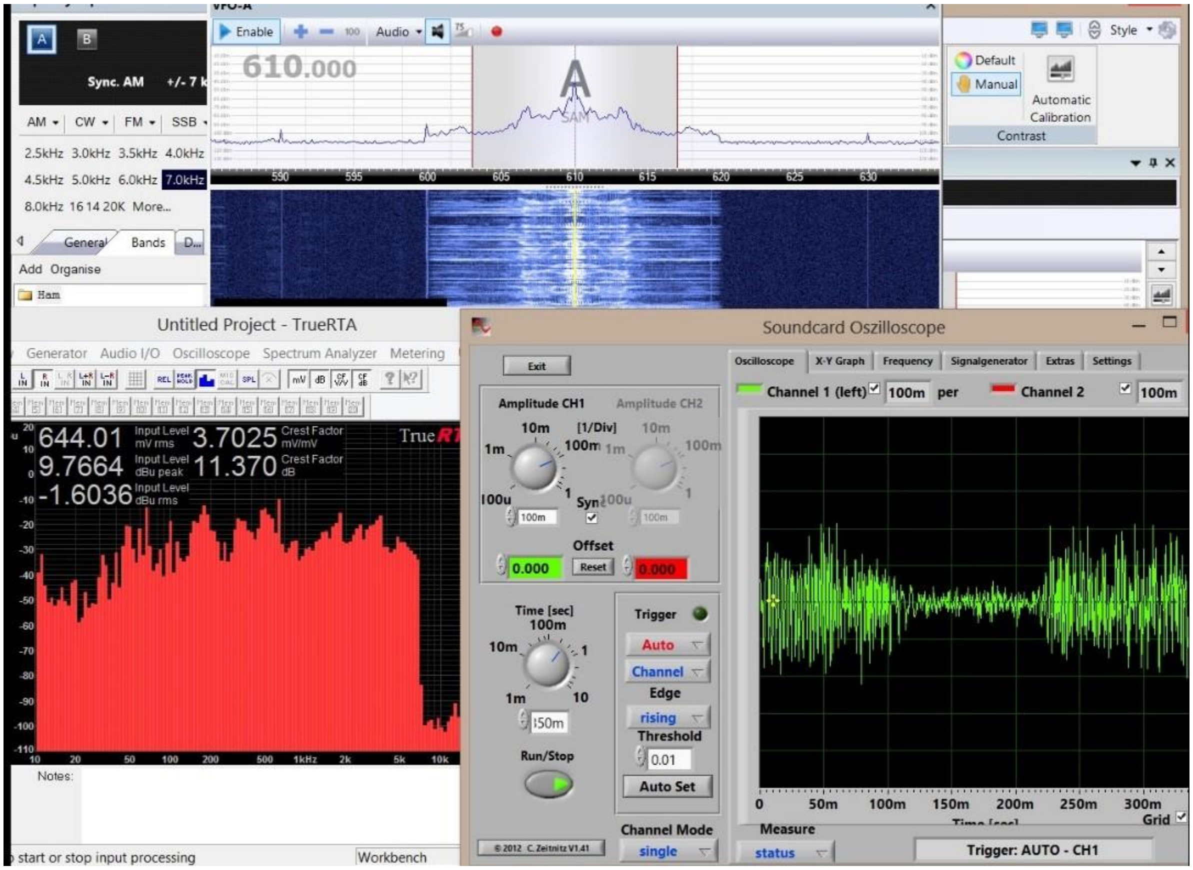
2.5K Wide AM Audio on 610 AM strong AM Broadcast Station

We can see that the spectral view is somewhat complicated to interpret a deference and I don't believe it's suitable for our visual comparison, we can use it to see bandwidth and Spectral displays are great for setting EQs. On the other hand, we can clearly see a difference on the Oscilloscope view.

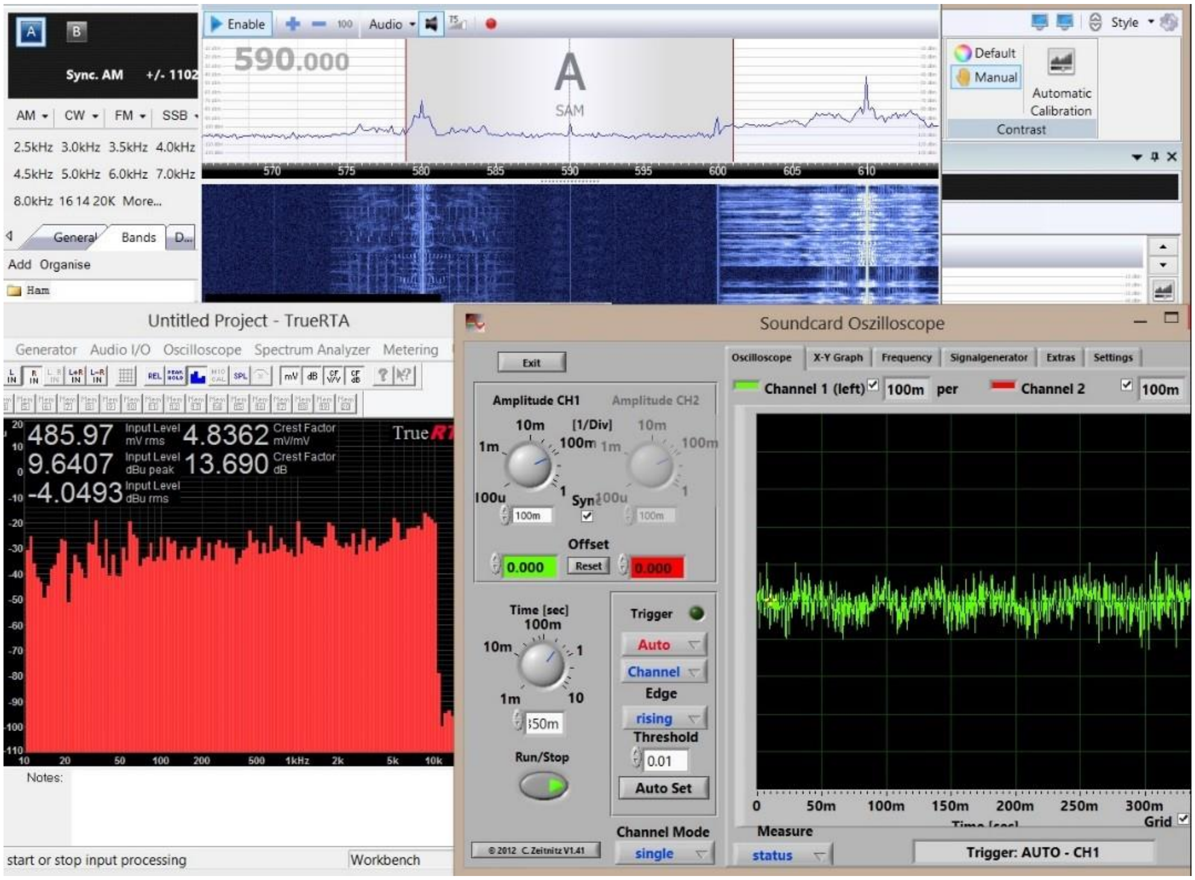
Here are a few more comparison where I have widened the bandwidth to 7K and then 14K.



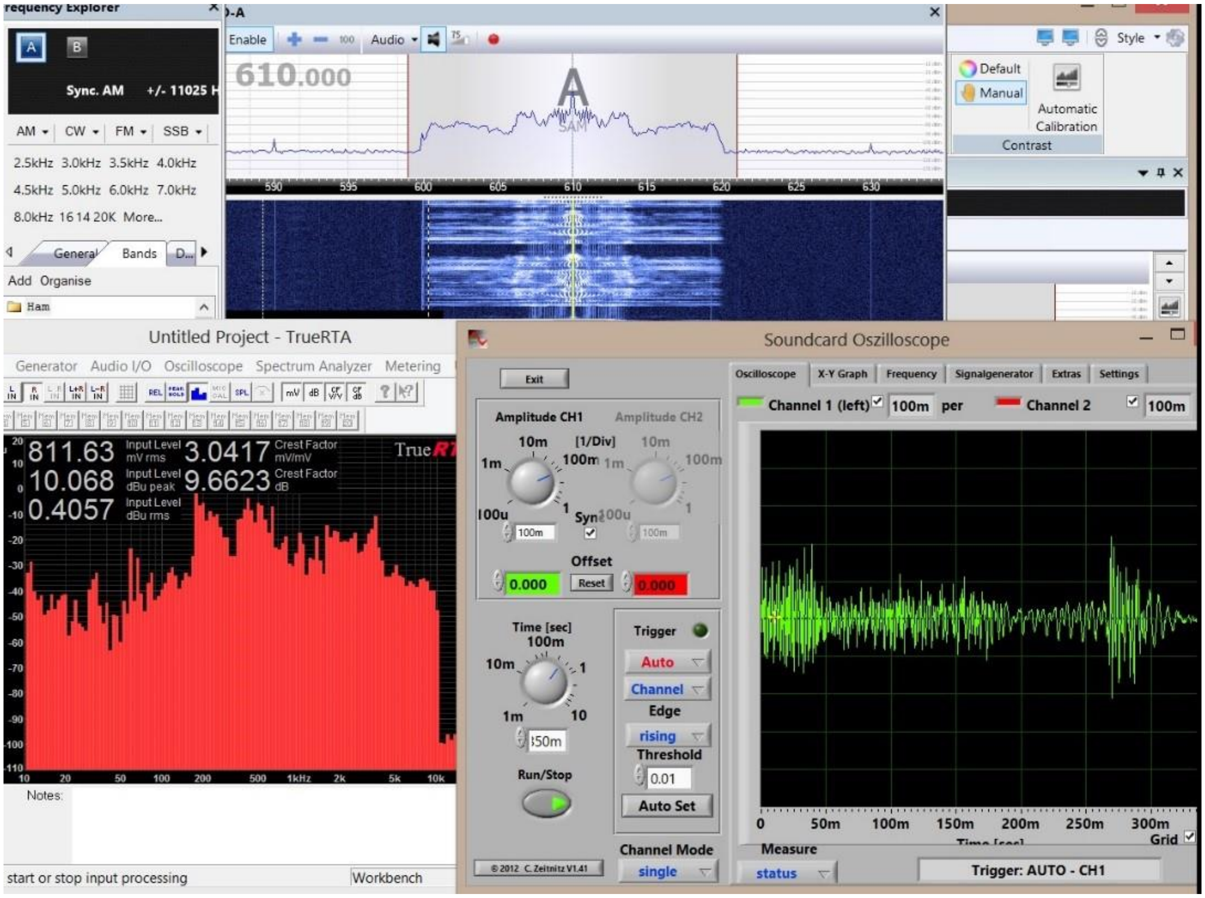
7K Wide Static on 590 AM to left of strong AM Broadcast Station



7K Wide AM Audio on 610 AM strong AM Broadcast Station



14K Wide Static on 590 AM to left of strong AM Broadcast Station



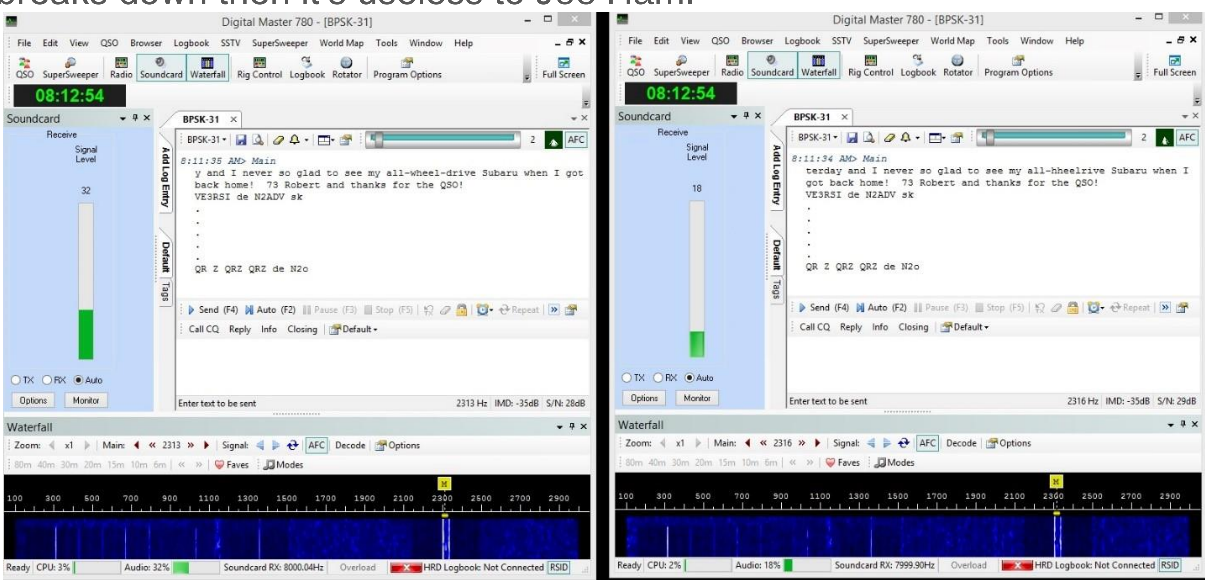
14K Wide AM Audio on 590 AM to left of strong AM Broadcast Station

You might note that on the 14K Strong AM Station that the spectral display did not show more than 10K. This was not the case with the RTR Dongle and looked like a possible limit of the Afedri. This is the kind of thing we can uncover using these tools and techniques. As it turns out, it's just the difference to listen to talk radio on AM verses classic rock music on the dongle which as we discussed earlier has a much greater tonal range as seen on the spectrum analyzer.

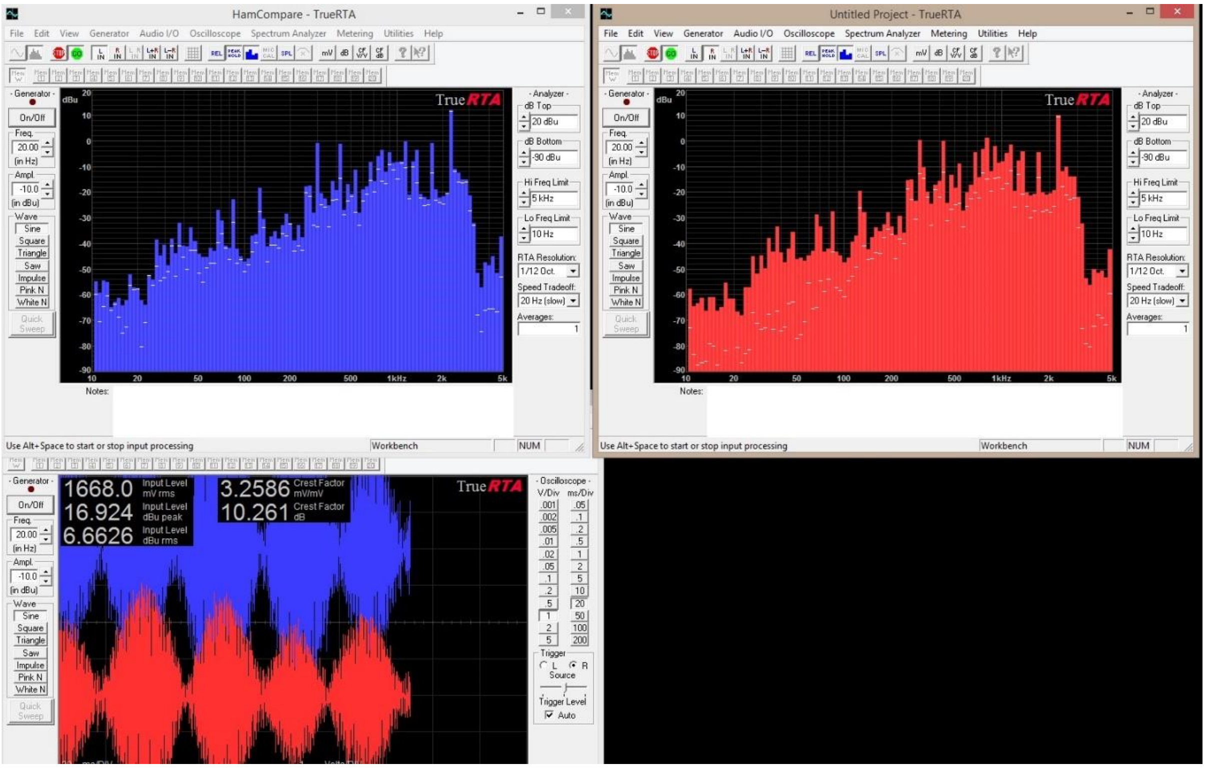
What I believe is that for comparing weak signal reception we can better create a visual reference with regards to the view on an oscilloscope than we can a spectral display. The spectral display is still useful though and with some other more expensive software, there are more possibilities. On a budget, it's hard to beat an oscilloscope. More specifically, if we attenuate the incoming signal to both radios we can see at what point we loose an audio wave form as we increase volume and the controls on those radios and we see the typical static wave form. We can measure the point in attenuated DB where the signal failed to register. We can also create a reference in amplitude to when a signal is no longer copyable.

What about Digital Modes? Well, if you follow my videos I have had several boring ones that scope comparisons of radios in DM780. At one point I dismissed this as a viable means of comparing radios for Joe Ham. I believe I was wrong to dismiss this method and here is why.

If DM780 or a similar digimode program can't decode the signal any longer as the signal weakens, then Joe Ham is going to have a problem. It's really that simple because its literally you see what you get and if decoding breaks down then it's useless to Joe Ham.



Anan Left KX3 right 30DB Attenuation on 14,070mhz



Corresponding Scope and Spectral views (Anan Blue & KX3 Red)

I will spare you lots of screenshots at this point in time. You can see the spectrums of the two radios are very similar. Keep in mind the volume levels are not identical and we have some latency between the two radios as well.

As I referenced earlier in this article we can always see audio signals on the scope. Voice and digital signals look difference and if you vary the sweep speed you can see different waveforms and characteristic.

With spectral analysis tools we can look at the tonal balance of the audio we are receiving and compare radios.
Its my belief that as we compare weak signal reception using these basic audio analysis tools we can provide some visual references.

For example, I could tune both radios to a weak signal and then further attenuate that signal using a common variable attenuator and watch what happens. One radio might breakdown and loose the signal faster than the other.

In a spectral analysis we might see how the audio breaks down, perhaps it loses its highs faster than the other.

Also with spectral analysis we can see why one radio sounds different, better or worse and show visually why that might be due to its tonal components. Perhaps the highs are more pronounced in one verses another.

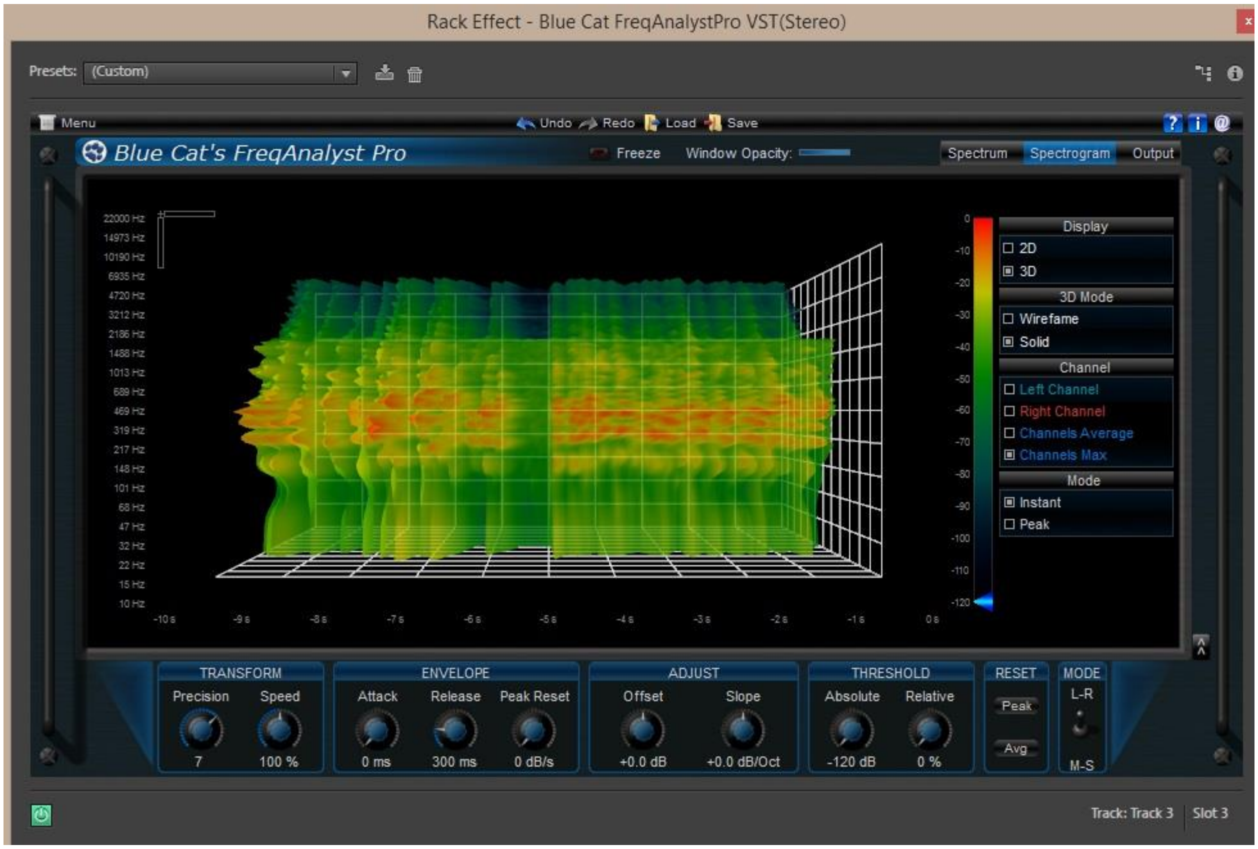
These next screenshots show some differences I saw between the two radios. Take a look at the two spectral envelops on this frequency analyzer view.

We can see some differences in the cutoff or slopes of the KX3 vs the Anan. I believe what you are seeing here is the roofing filter on the KX3 is on and I have set a 20hz - 3000Khz filter range.

One thing that is also notable in just listening to the two radios you can hear more hiss on the Anan where as the KX3 seems quieter and more copyable. Note, the Anan was also set to a 2.9K filter width.

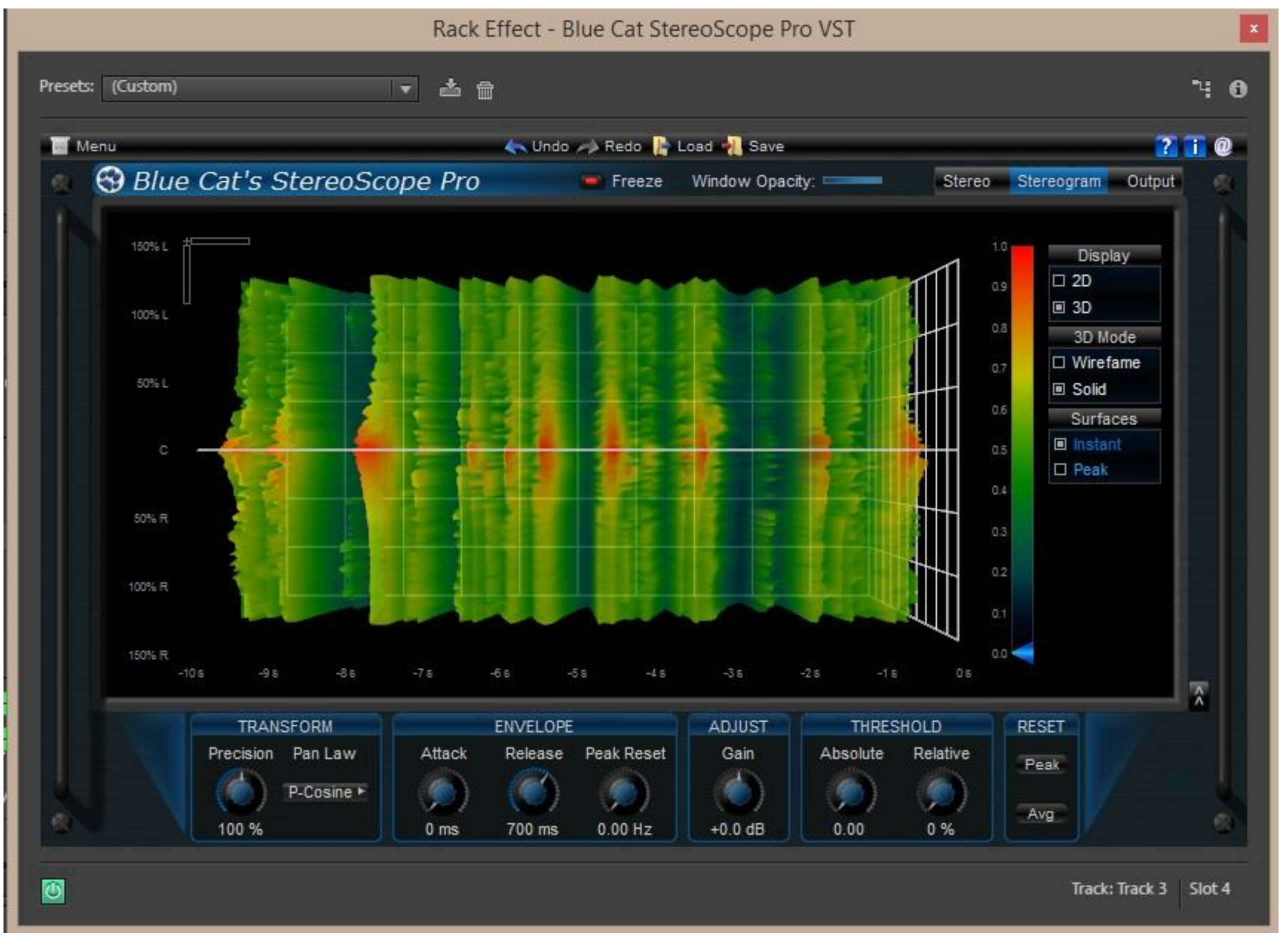
I am not sure what to make of the next graphic. Its a 3D heat map view of the two channels. Its really meant to look at the tonal components. You have to divide the view in half for each channel. The top half is the Anan and the bottom half is the KX3. Each half represents a full tonal range with a center to outside mirrored view.

So the bass is in the middle and the highs are on the outside edges. We see that the KX3 signal looks like is stronger with more orange in it, this is only a volume input difference. The highs on the Anan look different though, they look to slant backwards on a 45 degree angle where as the KX3 looks flatter. I dont know what if anything this means yet, however, I am really curious to find out!



Next we are looking at an oscilloscope view, you can see the minor latency between the two radios and they are labeled and overlaid. In this view we really don’t see anything significant right now other than both are producing voice audio signals. This sort of view as I said earlier might be interesting if we weaken the signal and see a greater and more rapid decline on the amplitude of the signals that the other.

This is a stereogram view, not really a whole lot different then the first view we looked at.



This is really just the beginning of my exploration into all this. I have had a ton of fun and there are literally thousands of VST plugins a ham can use far beyond what we get in our current ham software offerings to improve audio. There are broadcast audio noise reduction plugins, techniques we can use with gates and limiters, equalization which by the way a spectral analysis is highly useful, filters and the list goes on.
I also added some new graphs to the article showing some more detailed comparisons using the full licensed versions of the Blue Cat Audio Analysis plugins and in one, the first, we clearly saw a different curve response between the Anan and the KX3. In fact the difference in part was the roofing filter and as you adjust it on the KX3 you can literally see the audio frequency response change. It narrows the curve if you narrow it and widens it as you open it up.

Even without the roofing filter though you can see that the KX3 clearly has a more narrow and greater slope on the highs which may be in part its more limited and narrow response output limit of 4.2K.
I referred to this in the KX3 review and it being a limit for shortwave listening audio quality running direct from the radio.

Interestingly with the averaging on, the KX3 audio looks stronger (the higher lines) whereas the lower line views are what you see un-averaged and in real time that were frozen at the time of the screenshot.

For fun I enabled the EQ on the Anan and started playing with it. Interestingly enough it did not respond nearly as effectively as I would have liked to have seen so I downloaded some EQ Plugins and some denoiser plugins and have started playing with those. Note this is not a slam on PowerSDR, I am experimenting here and reflecting as I go.

Here is a view with a sharp Anan EQ Curve cutting off the highs and lows and then an extreme KX3 roofing filter setting on chopping off the lows so you can see the effects of the changes. Look for the lables to help you sort out which is which.

Next I took a demo Parametric EQ Plugin and applied it in my DAW. I shaped the curves visually to more closely emulate the KX3 curve.

Here is the same plugin running on the KX3 for apples to apples comparison. You can see I have not applied any curves.

Here is the combined Frequency Analysis from Blue Cat.

So you can see the frequency response is much more similar using the DAW to reshape the sound. I would say this is pretty convincing evidence of what we can do with a DAW and Audio Processing verses what we get in the radios themselves. Again, this is not a slam on the radios, merely an observation.

To be fair though, you have to buy a DAW and plugin costs could add up. The GlissEQ and the Span Plus VST Plugins would run $100 each to purchase if you liked them. There are hundreds of free and demo EQs you could likely lay your hands on.

The big question you might have is did I hear a difference. Yes, the Anan now sounds a lot quieter and more like the KX3.

I have to say as a non audio engineer type person that I gain more and more respect for those guys as I plunge into this journey. There is quite a bit to learn and understand.

Noise Reduction

This happens to be a really nice article on Noise reduction plugins, if all this interests you, check it out here:www.sonicscoop.com/2013/05/30/the-best-n...ugins-on-the-market/

In this screen shot I have a Decrackler, Denoiser and Voice Denoiser running. The Denoiser itself has the most dramatic impact which I would say is mild in terms of what your ears here. I have to eat some crow here and point out that the NR on the KX3 is quite impressive and apart from the lost plugin is superior to these so far that I have been playing with. The PowerSDR NR though doesn't compete with the plugins.

Lets look at what the Denosing does to the curves on the Spectral Analysis. It gratly flattens and reduces everything broadly and effectively undoes the Roofing Filter and or the EQ curves applied to the Anan.

You can find more detailed text on Noise Reduction in the next article on Software Defined Audio. Login to read it now!

WRAPUP

I have had a blast with all this and I will offer my humble disclaimer that I might be all wrong in my Joe Ham assessment. Time and your feedback will tell as I continue to explore all this. Below the wrap-up you'll find some test scenarios I explored and some notes I have made on them.

I want to say thanks to Mike Alexander and the nice discussions we have had on this topic. I know he is also exploring this on his own as well and I look forward to what his views will be on the subject. He's going some places I have not and I think you are really going to enjoy his offering on this topic and actual implmentation.

All this leads me to new exploration as I move forward. I have purchased the Blue Cat Software Audio Analysis Plugin Set and will be delving into it more to make my comparisons. What was shown here was the trial versions. You dont need them. NUGEN Audio makes a $89 Plugin that accomplishes most of the same fuctions if you want to play. Voxzengo does as well with a plugin called Span. TrueRTA does a fine job, offers a scope and other useful tools and doesnt require a DAW.

There was another spectral package I was highly interested in, however, it required an iLok key (USB Common Software Licensing scheme key) to try it out, so I got the key to explore that plugin as well as others that require the key for trials.

While Flux Pure Analyzer Pro tool looked extremely promising for richer spectral analysis, in my first attempts to play with it, I have found the BlueCat tools I purchased to be more effective in looking at the signals. Interestingly enough turning the sampling rate up on Pure Analyzer I was able to munch up the most CPU I have ever used on Hamzilla.

Really True RTA and a Free Digimode program could be used with a sound card in your PC to facilitate this type testing. As you can see, we can be far far below our budget and build up from there! If you like the idea of VST Plugins you can get a DAW like Reaper and then access the tens of hundreds of free plugins to explore even more! It would be debateable to some degree where a external interface in simple operations would be less capable than an audio interface. Soundblaster and ASUS make some really nice 124DB capable cards right now if your into that sort of thing.

Fortunately with Hamzilla I continue to be able to delve into more and more tools around my software defined radio and still have lots of room to grow! If we go back up to the example where it looks like the Anan is producing more hiss with its wider envelop, we can use an EQ on the received audio or other tools to possibly clean it up and sound as good as the KX3. That's a real example of the power of using a DAW in our receive audio chain!

Another would be to use a parametric EQ for notch filters, so much for your knobbed radio not having software defined radio notch filters! just run your audio through a DAW, add a good parametric VST plugin and your in business. I think now you can see what a killer App for your radio looks like and on virtually any radio of your choosing.

Last and certainly not least will be further exploration into ham radio audio analysis and developing those visual references I hope to be able to share in future reviews. I hope to include an audio analysis readout and comparison in those reviews. I still have some of the radios I reviewed and so I will likely make forum posts here to share whatever it is I eventually develop and find worthy of sharing.

I hope you have enjoyed this article and the Joe Ham exploration into ham radio audio analysis! This is a huge subject to cover so additional content to this article will appear in the forums here. Here is a link to the continued discussion.

https://sdrzone.com/index.php?option=com_kunena&view=topic&catid=42&id=199&Itemid=155#654

ARTICLE END

Joe Hams Audio Based Testing Notes

All said and done we need to start to tie a bow on all this and document some models for further exploration.

Below is the first draft of some proposed low budget testing we can perform in our shacks to compare radios.

These models will require actual testing and refinement and this document will capture those efforts and the artifacts that they generate, test procedures, checklists and references that result.

Each model is being developed and tested for effectiveness and to provide sample results and baseline radios results.

Multiple hams are encouraged to run the same tests and compare results to determine consistency and variances on samples radios tested.

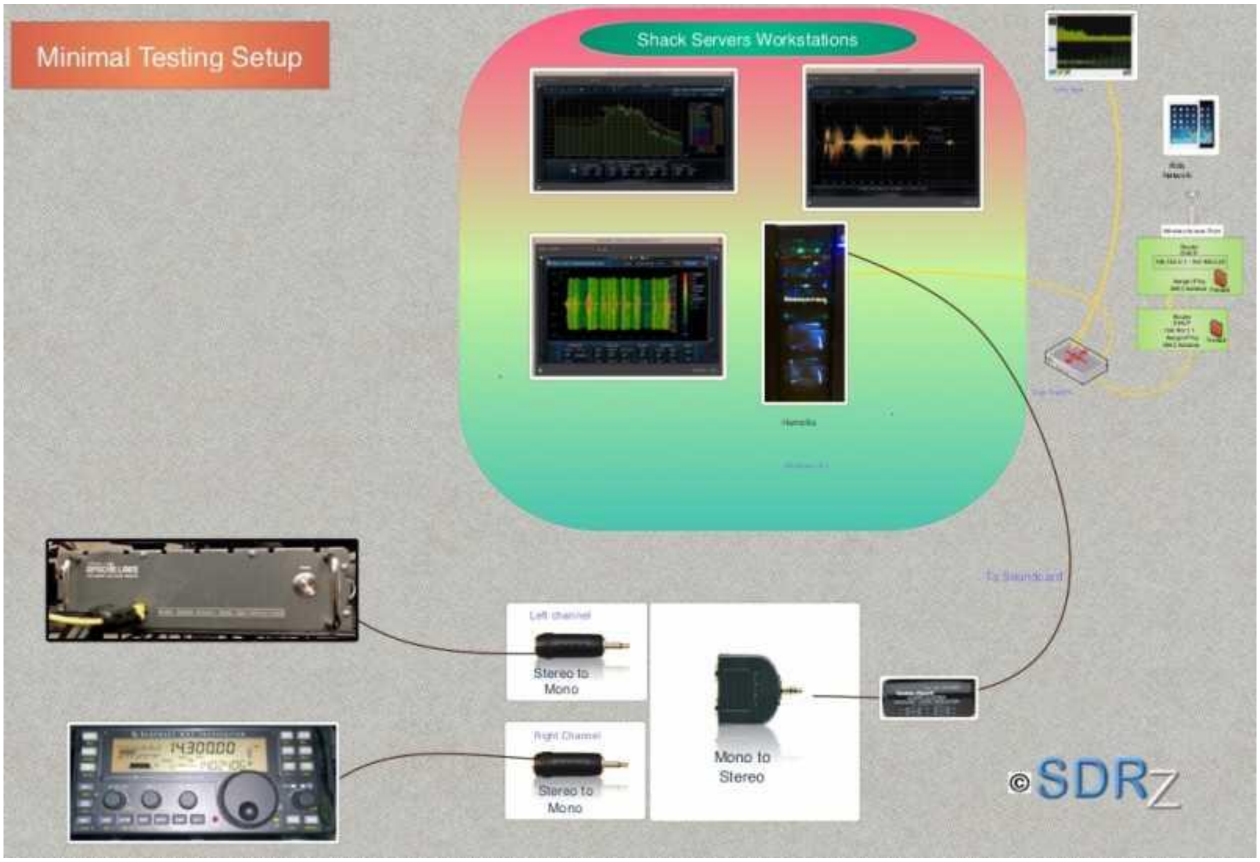
The result can help a ham know how his own radio compares to someone else's as the tests can stand individually.

Tools

An Oscilloscope with a way to couple the audio from one or more radios to one or two channels as appropriate. You can use a soundcard scope or a physicall scope which may perform better. PC Occiloscope or TrueRTA can be viable options so long as your PC can handle them and has a decent soundcard. If you dont have an occiloscope and want to play PC Ocilloscope is hard to beat for a whopping $15 license.

While DAWs and Interfaces have been explored and referenced extensively here, one does not need them to make these simple tests if they have an occiloscope.

Test 1 and Test 4 are the ones I deemed to have the most merit and plan to pursue going forward.



Test 1

Weak Signal Performance
A scope view and indicator of how many millivolts a received audio wave needs to be registered and visualized on a scope to copy a QSO.

Testing found this value to be somewhere between 200mv to 250mv.

The thought is that we can break down weak received signals with an attenuator and increase volume until we hit that magic reference and we can no longer properly and reliably copy audio to make a QSO.

The initial tests appear to hold true regardless of the original signal strength. Whether the signal was very strong or weaker, X amount of attenuation applied resulted in a drop in the audio amplitude and became uncopyable below 200mv. Noise increased as attenuation increased and so the 200mv figure reflects the competition between legible audio and noise. A clean signal could likely be heard far below 200mv, however, we are striving for more real world conditions that hams actually deal with when operating a radio.

We can do this with one or more radios on a bench and watch the effect and response and when each breaks down.

Limits

The failure in this logic is the internal audio amp may distort the audio to the point it also is not copyable, even though we see the wave over a copyable level. This might just need to be noted in a test..

Distortion did play a role here as there was a point where increasing the volume more to increase the amplitude did not result positively and simply raised the noise and created additional undesirable artifacts in the received audio.

Digital Modes do not need to be considered here as we will measure those differently.

Implementation

A reference view will be provided which shows 3-5 levels of a signal and its legibility.

Views of the radios tested views side by side to the reference showing how much attenuation was applied for the radio to pass through all 3-5 levels.

The scope view will also show the breakdown point of each radio in attenuation DB.

TrueRTA $100 for full license.

Additional Possibilities

A spectrum Analysis of each radio as its being tested to see how its audio characteristics change under test may also be of interest and or revealing.

Procedure

1. Find a moderate signal on each band to test (Will be selected at time of test based on live traffic on the band).
2. Connect two radios to compare to your sound input.
3. Tune both radios to the selected frequency
4. Tune the radios optimally to receive the signal to the best of your ability using the radios controls. These include AGC, Equalizer settings if you use them, filters ect.
5. Use an audio program to make sure that the volumes are set as equal as possible and that the tuning settings will persist across increasing your volume to the point of distortion as it makes sense to the speakers. You will need this throughout the test as you raise volume levels with increasing attenuation.
6. Setup any other analyzers you plan to use, oscilloscope, audio spectrum analyzer, ect to monitor and view audio from radio.
7. Validate that amplitude and time divisions are set to your liking on the scope and analyzer. These should show relatively equal amplitudes for both radios.
8. Attenuate the input signals until the amplitudes on one or more of the radios reach 250mv. You may need to adjust your scope as this occurs since the amplitudes will become greatly reduced.
9. Raise the input levels on your radio volumes as much as makes sense and repeat this process until one or more of the radios no longer present a copyable signal. At this point you will have reached the threshold on one or more of the radios and you can begin to adjust and take readings to see where each radio breaks down and whether one can still present a legible signal over the other at one attenuation level over another.
10. You are encouraged to adjust the radios to the best of your ability as such that it performs as best as it can to achieve a copyable signal.
11. Record the signal levels and copyability. Capture Screenshots.
12. If one radio is performing better than the other, change your focus to attenuating more until you find its break point and then record its levels. Capture Screenshots.

13. Start over again and run the test three to five times for each band. Select a new source signal each time. Record the results into the spreadsheet and average them across the three to 5 tests.
14. Compare results

Making sense of the results

I believe this is best represented as a ratio to account for the fact that we are using varying random signals for testing.

We can possibly look at an attenuation to output ratio to correlate performance.

A very simple formula would reflect the following conditions:

If two radios were equally attenuated in DB, however, one could produce more legible audio at a lower amplitude waveform then it would be the better performer.

If two radios were attenuated in DB, however, one could be attenuated more than the other and produce equally legible audio at a similar or lower amplitude waveform then it would be the better performer.

A formula we can use to produce a result where DB increases and mv decreases showing a positive result looks like this.

Rating = [AttenDB x (1/mv)] x 1000

Testing our formula to prove it works I am providing the following worksheet view:

Atten DB	Break mv	
30	180	166.7
30	200	150.0
30	220	136.4
Atten DB	Break mv	
34	200	170.0
32	200	160.0
28	200	140.0
Atten DB	Break mv	
30	200	150.0
32	180	177.8
28	180	155.6

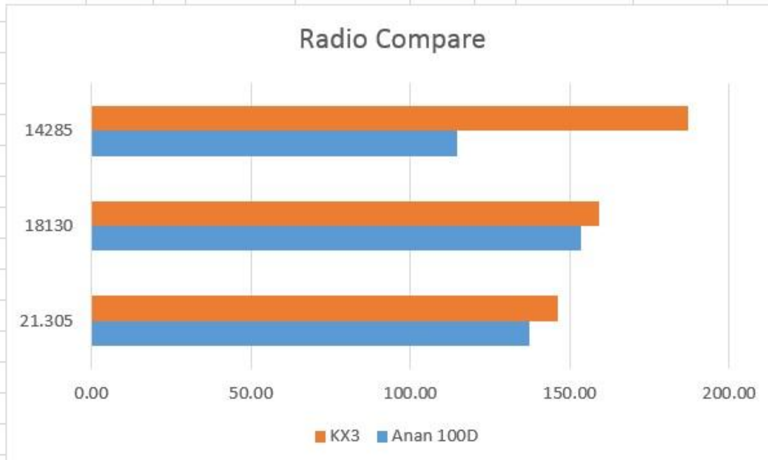
We can see then that it tests the conditions outlined and passes each test. Please keep in mind the number is not intended to be representitive of anything else than a functioning means of showing performance. IE, there is no scientific term or relevance behind it. Call it Joes Law if you want! :)

A example (not real numbers) comparison might look like this:

Anan 100D	Avg Score	PASS 1				PASS 2				PASS 3		
Band		*Atten DB*	*Break mv*			*Atten DB*	*Break mv*			*Atten DB*	*Break mv*	
21.305	137.18	*31*	*223*	139.0		*32*	*235*	136.2		*30*	*220*	136.4
18130	153.58	*34*	*210*	161.9		*32*	*215*	148.8		*33*	*220*	150.0
14285	114.88	*28*	*250*	112.0		*29*	*245*	118.4		*28*	*245*	114.3

KX3		PASS 1				PASS 1				PASS 1		
Band		*Atten DB*	*Break mv*			*Atten DB*	*Break mv*			*Atten DB*	*Break mv*	
21.305	146.19	*32*	*215*	148.8		*31*	*220*	140.9		*32*	*215*	148.8
18130	159.18	*36*	*220*	163.6		*34*	*225*	151.1		*35*	*215*	162.8
14285	187.00	*43*	*223*	192.8		*41*	*228*	179.8		*42*	*223*	188.3

	Anan 100D	KX3
21.305	**137.18**	*146.19*
18130	**153.58**	*159.18*
14285	**114.88**	*187.00*



This test methodology will be followed in an actual test and a real comparison will be produced and shared.

Please feel free to try this yourself, post your findings and results in the forum and let me know what is wrong in pursuing performance this way.

Colaboration will make this effort and path better!

Test 2

Tonal Performance

This would be an intelligent spectrum analysis view with comments and visual references to the overall tonal quality of a radio.

It will cover how a radio sounds in relation to other audio devices. Pitchy, Bassy, Flat, Shrill, ect.

Limits

Some research or experimenting needs to be done to determine what qualities possibly lend themselves to better performance and or more pleasurable listening experiences. They may be different and of course there is fatigue.

Googling can yield interesting results and ironically I was able to assemble a foundation from the following links.

Hearing Aid Optimization

https://www.communication.northwestern.edu/departments/csd/research/hearing_aid_laboratory/files/ENTJF10_Souza.pdf

Reading Audiograms

http://www.firstyears.org/lib/howtoread.htm

1. Vowels fall in the "louder" ranges (They lie lower on the chart.);
2. Consonants are higher-pitched than vowels (They lie more to the right on the chart.); and
3. Consonants are spoken more softly than vowel. (They lie higher on the chart, in the lower decibel ranges.)

Headphone Testing

http://www.audiocheck.net/soundtests_headphones.php

http://www.audiocheck.net/audiotests_dithering.php

Implementation

An audio spectrum reference view will be provided which radio views can be compared against. These can be marked up to show the unique traits or points of concern or note.

TrueRTA $39 - $100 for full license.

Conclusions

In my humble opinion, and sadly, this is not a worthwhile test. Sadly because I spent some money on plugins and while they are fun to play with I have not found the value I thought I would from them. Sometimes the best action or answer is no action and no answer. After reading enough about sound dynamics it's quite obvious that this is a highly subjective preference rather than something we can factually test and quantify.

What I did conclude is one might be able to use these kinds of tools to understand their own hearing shortcomings and preferences. Interesting and really rather obvious is that not only can an EQ make your audio sound better, it could also be used to make you hear better by allowing you to map your hearing profile to your audio output.

It is also interesting that hearing can be improved by having a visual queue to help augment it. This may mean that a ham with a panadaptor or other visual queues may actually have an advantage over another.

While its true we can use audio spectrum analyzers to help visualize tonal characteristics of the audio we listen to, it cannot account for one's own preference and hearing capabilities. It is therefore pointless in my opinion to try and establish a one size fits all model.

Test 3

Total Harmonic Distortion

We can measure this by injecting a known signal into the receiver and measuring the output. An audio Analyzer supporting THD measurements can be used to compare the input to output and the change/distortion through the radios receiver circuitry.

If we want we can do the reverse and use the transmitter to transmit a known signal and measure the signal as received and subtract the receiver THD.

We could also make measurements with regards to how the signal source is distorted by the receiver’s amplifier as we attenuate the signal and raise the volume.

Limits

I have not really identified any limits on this right now other than a very low power transmitter and the proper coupling, attenuation to insure safety and staying within the rules.

Implementation

A straight forward test report can be provided along with a reference radio report.
TrueRTA $39 - $100 for full license.

Additional Possibilities

A spectrum Analysis of each radio as its being tested to see how its audio characteristics change under test may also be of interest and or revealing.

Status

I do not intend to pursue this test at this time. If I can find an exciter board for my QS1R I might look at this again and potentially other tests as well. I may consider using my KX3 for this as well if the exciter board doesnt become readily available (no longer being made). I would need to make sure I had the correct coupling in place to prevent any damage to my receivers. I dont believe THD to be relevant enough to invest lots of money into testing. Also, really, tests 1 and 4 seem to be the tests that are going to end up mattering most to Joe ham as they capture the total experience into their testing.

Test 4

PSK/CW Modes

This is a simple comparison of two radios using a digimode program and breaking down the signals going to both radios and seeing which one stops copying first.

Again one had a known transmitter and stream you could even measure this for any radio within the controlled environment.

Limits

This will be attempted with over the air received signals and as such no two tests will ever really be the same. This might also be best served by using a low level transmitter coupled to the receivers being tested and using a real and known repeatable signal so conditions are identical. A QS1R with Exciter or other very low power transceiver could potentially be used like this.

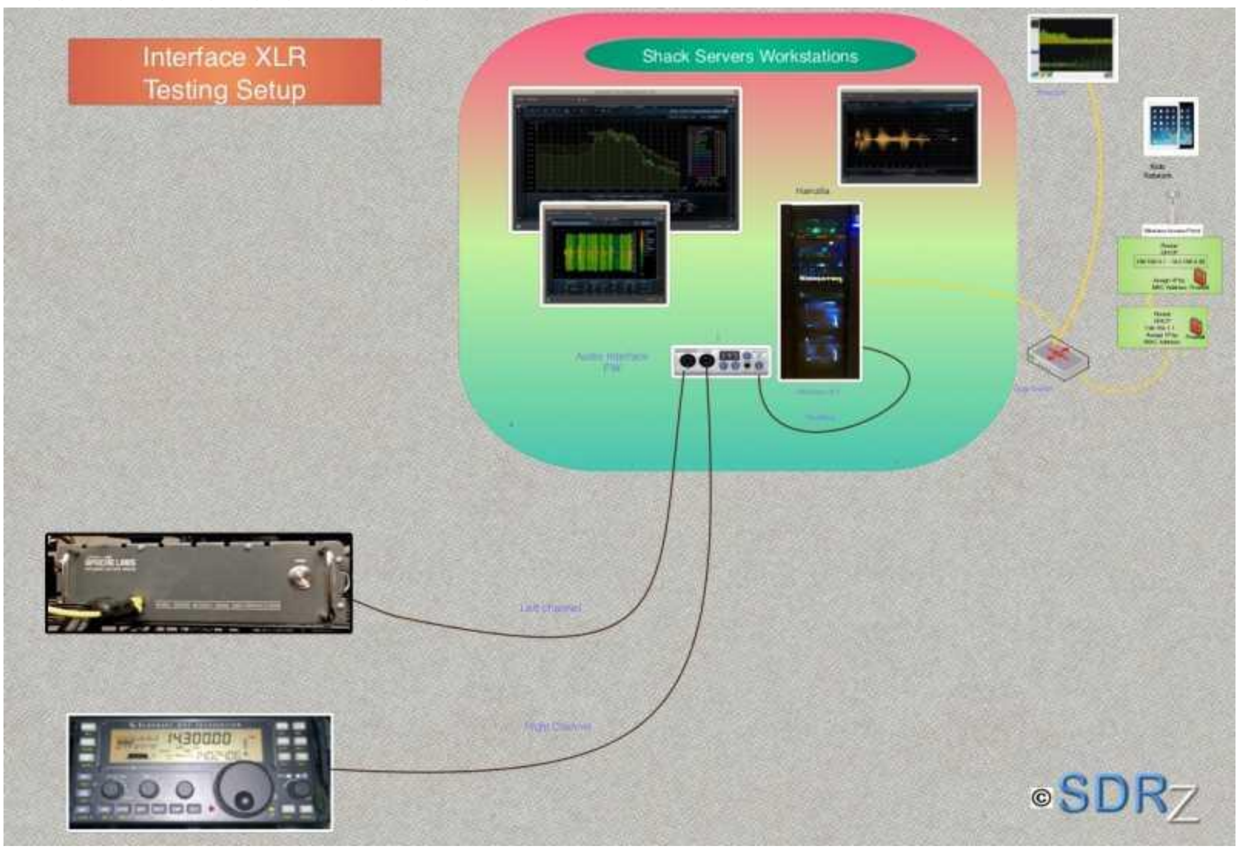
Implementation

DM780 Screenshots of the radios breakdown points in attenuated DB will be provided.
Ham Radio Deluxe $69 for full license, others for free.

Status

This test will in large part mirror much of the procedure in Test 1. The primary difference being DM780 will be used in addition to or in place of an occiloscope.
The readinds for each mode and band can be recorded, a forumla applied and average performance results can be plotted and graphed.

Additional Overall Notes



VAC vs Physical Audio Jacks verses Sounds Cards
Individual radio settings will play a factor as well and the logic here from a Joe Ham view of the world is that the tester has to understand how to set the radio to its best possible settings prior to any test on any frequency. There may be limits to what you can do on some radios and a needs to test it multiple ways on others. I prefer physical jacks, however, some radios I have do not have any and the choice of sound card one uses to output to may be as much a factor as the radio.

73!
NI0Z