Flex 6700 Review - Part 3

SDRZone

Flex Radio Signature Series Model 6700

Review

Part Two - Installment Two – Phone Comparisons and Measurements

May 30, 2014

Reviewed by Michael Alexander - N8MSA

Signature Series Model 6700 HF/VHF Transceiver

FlexRadio Systems, Inc.

Retail Cost =$7499.00 (without options – see discussion in review)

Review Type = User experiences (Part One), with some measurements and comparisons (Part Two)

Radio Architecture = DDC SDR HF/VHF Transceiver

Overview

The FlexRadio Signature Series Model 6700 is Flex's "flagship" software-defined radio (SDR) amateur radio transceiver, and the top offering of a series of three radios. The Signature Series marketing materials boast that the Signature Series being the most advanced, capable and easy-to-use transceiver in a rather narrow field of such radios. The design brief of this radio is, in the fewest words possible, to do as much of the digital signal processing (DSP) inside of the radio, thus allowing the use of low-bandwidth network connections for human interaction with the radio. This distinguishes itself from virtually all other "commercial" amateur and most "open" SDR designs that rely on PC to host the DSP routines.

Part One of this review discussed this transceiver as it relates to the things that typical amateur radio operators demand from a radio in this price class: the ability to "hear", how it "sounds" on the air, how it integrates with a modern "shack" and similar topics.

Part Two expands on Part One with some real-world comparisons with several contemporary transceivers, including the Apache Labs ANAN-100D and the Elecraft KX3. Installment One discussed testing methodology, and Installment Two (this article) will discuss the results of the tests.

Note: a companion video has been posted to YouTube.

Special Note - SmartSDR Versions: SmartSDR/Signature Series firmware version 1.1.3 was released as this review was underway, and was used for this review. Version 1.2 was released as this installment was nearly complete and, rather than discard everything collected to that point, it was decided to post this with the information obtained while using 1.1.3. Version 1.2 brings with it addional features that will be of particular interest as we attempt to describe and quantify CW audio performance. This update seemed to have little, if any, impact on "phone" audio.

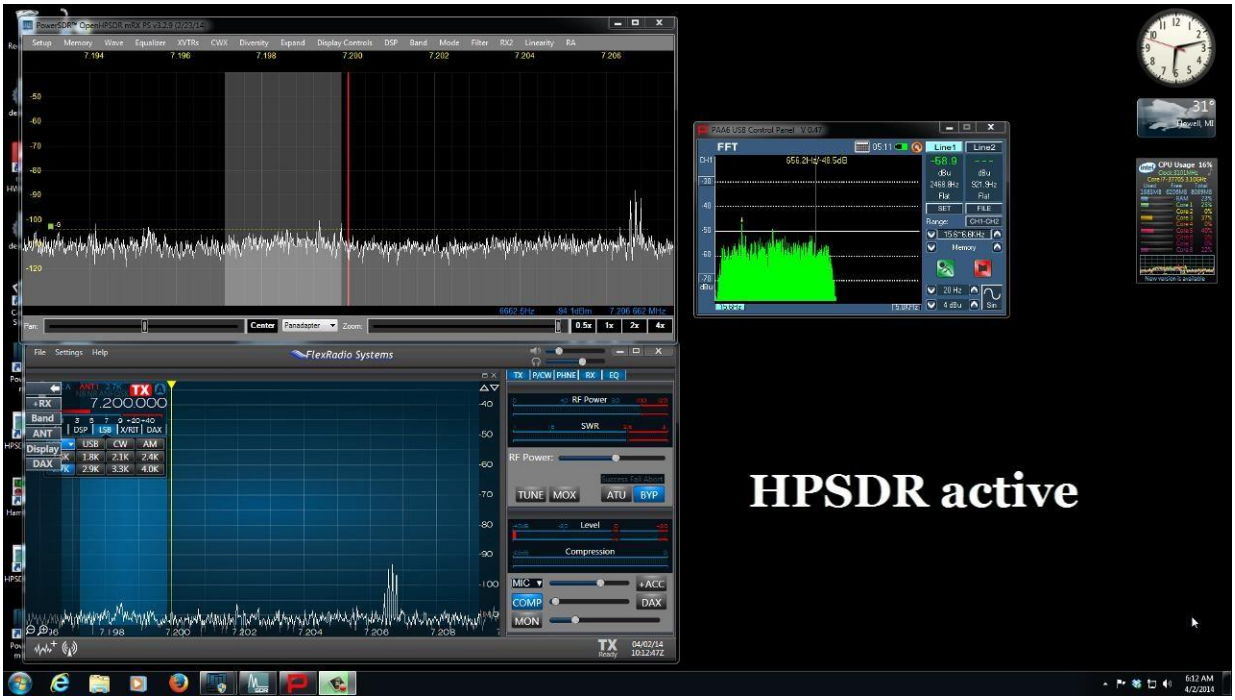
Receiver Comparisons – SSB Audio Performance

To recap, the methodology for this comparison is to configure the test radios to as close as identical as possible, and measure the results. The results were, to say the least, interesting…

Two facts became apparent during the tests: the Signature doesn't retrieve as much audio from an RF signal as some of its contemporaries, and several of the DSP features are only modestly effective at best. Specifically, the Signature "doesn't hear as well" as the latest OpenHPSDR configurations (software and firmware) or the Elecraft KX3. ACG "fast" settings, on most modern radios, provide the most AGC gain for "weak" signals. The difference between "noise loudness" and "voice loudness" was immediately noticeable between the radios, with the OpenHPSDR and the KX3 roughly similar (with a slight edge to the OpenHPSDR), and the Signature producing sometimes as much as -6 dB

less audio. The Signature, in fact, would produce about the same level of audio when fed a weak signal at a “fast” AGC setting as the other two radios would with the AGCs set to slow.

Why would that be the case? It’s my impression, based on a brief comparison between a Flex 1500 and the Signature, that both radios “sounded” very similar. Even more interesting was the observation that the Flex 1500 and the Signature both “sounded” very similar to “early” OpenHPSDR PowerSDR, namely versions prior to PowerSDR mRX 3.2.7., which still use much of Flex’s long-standing DSP code. I speculate that the Signature is using the same algorithms that prior generations of Flex products have, and that may explain why those three systems behave in such a similar fashion. The other possibility is, and I consider this to be somewhat more likely, is that Flex Radio's ability to program the DSP processor - the TMS320DM6168CYG4 - is at a level somewhat behind manufacturers that have been using similar parts for nearly a decade, such as Yaesu and Icom. I have no doubt that Flex Radio Systems can develop and implement highly competitive DSP algorithms in this device as the Signature Series matures.



It can be seen, looking at a screen capture of the audio spectrum analyzer, that the noise level from the OpenHPSDR drops several dB in response to a signal, making it seem “quiet” relative to the Signature. The Signature displays this behavior as well, but not to the extent that the OpenHPSDR does. The KX3 does this even less, but retrieves several dB more audio from an SSB signal than the Signature. These results were, as a reminder, with the audio noise level equalized (to the best of my ability) between all three radios.

To expand on this, I'll break down the difference into three key areas: just-above-noise-level (around +4 dB over the noise), moderately above-noise (around +12 dB over the noise), and strong signals (+30 dB over the noise). All of the radios perform the same with large signals, though there are differences in "listen-ability", especially noticeable with signal conditioners, such as equalizers, are not used. The radios are also similar in their ability to cope with very weak signals, with the Signature Series slightly behind the other radios used in this comparison. The largest difference was noted when fed signals in the +12 dB to +28 dB (above the noise) region, as this is where the Signature Series suffered the most.

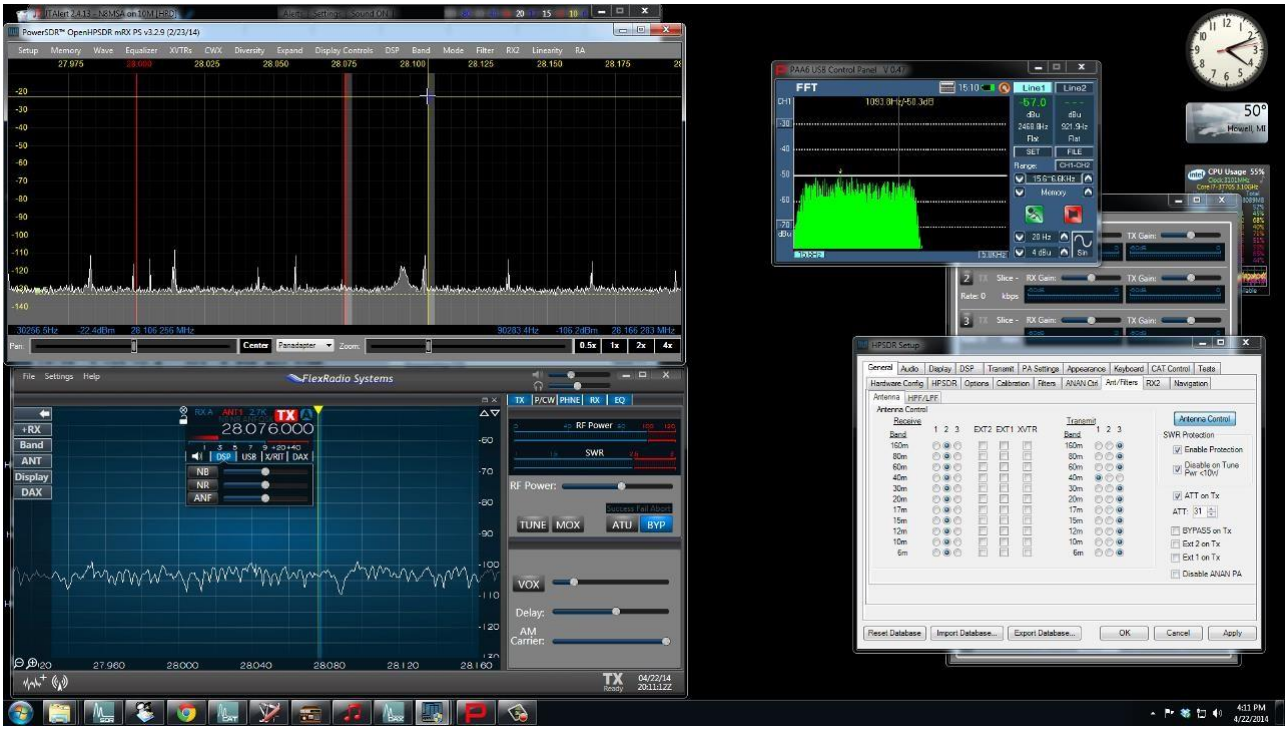
AGC Performance

The AGC on the Signature, aside from the relative deficit in retrieval quantity, performs very well. The AGC offers several modes (Slow, Medium, etc.) and an AGC Threshold slider with a range of 0-100. This allows the user to easily adjust the AGC performance to match the listening needs of the signal of interest; a low threshold, providing little AGC gain (to help tame “arm-chair copy” signals), to higher thresholds that help weaker signals “pop” out of the noise. The AGC itself works well, but again…the Signature doesn’t “hear” quite as well as the other radios mentioned and no amount of AGC manipulation was able to, in the course of this test, completely close that gap.

Noise Blanker Performance

Radio architecture (which includes, the case of SDRs, the software and firmware) has a significant impact on noise blanker behavior, which is why no two designs perform exactly alike. DDC SDRs provide unique engineering challenges, in that the DSP noise blanker algorithm is presented with a “window” of spectrum, limiting them somewhat in that they can only respond to signals inside of that “window”, where some IF designs permit hardware (or hybrid hardware/DSP) noise blanker to “see” a much broader spectrum. This can be an advantage in certain cases, allowing the receiver to respond “faster” and reduce apparent impulse noise in the demodulated signal. “Traditional” noise blankers can also cause significant distortion through the “modulation” of a signal of interest by a noise blanker’s response to an out-of-band signal. So it should be to no-one’s surprise that the Signature has some unique noise blanker characteristics…

Noise blanker performance in the Signature Series is difficult to quantify. SDRs, in general, use some manner of “look-ahead” algorithm to detect and suppress impulse noise and, to some extent, transients. This is, however, where the similarities end; all three radios varied significantly in noise blanker behavior. My initial impression of the Signature’s noise blanker was along the lines of “it’s not doing anything at all”; brief listening periods left me with the belief that the noise blanker was largely ineffective. It was only after subjecting all three radios to synthetic noise (an engine ignition noise simulation) that I was able to discern precisely how the blanker in the Signature behaves.



One thing immediately noticeable is, in contrast to OpenHPSDR and the I/Q output of the KX3 (not shown here), that signal visualization on SmartSDR doesn't change in response to noise action – at all. The OpenHPSDR variant of PowerSDR will rasterize the "post-DSP" spectrum, providing a visual indication of noise level reduction, where SmartSDR seems to show a "pre-DSP" spectra. The differences do not end there; enabling the noise blankers on these radios produced noticeably different results. Enabling the blanker on the OpenHPSDR radio would reduce obvious impulse noise, and not-so-obvious transient noise, encouraging me to enable the noise blanker even in the absence of obvious "spark plug" noise. The particular variant of the "least-mean-square" algorithm used by the OpenHPSDR would often clean up AC line "sizzle", uncovering a sometimes-vital last few dB of audio, and would sometimes show a several dB drop to the noise floor show in the PowerSDR display.

Not so the Signature: the 6700 would only reduce "classic" high rise-time, strongly-periodic impulses and little else. It seemed very effective at

cleaning up a relatively small population of noise profiles, but didn't provide the "sizzle" reduction that the OpenHPSDR and the KX3 were able to. Please refer to the still frame above, and the companion video, to see and hear the difference in behavior.

Noise Reduction Performance

Perhaps one of the biggest surprises I experienced during this review is the behavior of the Signature's noise reduction. Noise reduction is, in general terms, a collection of DSP algorithms that attempt to increase the signal-to-noise ratio of desired (coherent) signals above seemingly random noise. The radios that most people think of as SDRs have seemed to struggle to match the DSP noise reduction performance of traditional, or "hybrid", radios containing commercial-of-the-shelf DSP integrated circuits, such as the Texas Instruments TMS320C6727B DSP IC in the Yaesu FTDX5000.

The reason for this isn't difficult to ascertain: DSP chips have been constantly refined over several decades, using the vast resources of some of the largest semiconductor companies and with the help of a great deal of academic assistance. Hobbyist radio companies are, by comparison, much smaller and their research and development abilities reflect this disparity. The Flex Radio's solution to this problem is, to the best of my knowledge, a first in this particular market segment: they put one of these DSP chips in the Signature Series radios. Has this strategy helped the Signature out-perform other "pure" SDRs in this area?

The answer is, in a word, "not yet". The noise reduction is, at this time, very ineffective. It's worth noting that noise reduction is, on most any radio, something that…reduces noise. I have only heard a couple of receivers that make weak signals more intelligible under certain, specific circumstances; the primary purpose being to simply make an otherwise adequate signal more pleasant to listen to. The Signature's noise reduction really doesn't make much of a difference, either to the ear or on the spectrum analyzer.

Automatic Notch Filter

One area where all three radios seem to be similar is in the area of automatic notch filter performance. The version tested of Signature software tested provides an effective automatic notching capability, but doesn't offer a manual notch filter or Flex's hallmark "Tracking Notch Filter".

Note: Tracking Notch Filters have been added in SmartSDR v1.2.

Receiver Comparisons – AM Audio Performance

I was originally inclined to simply organize this installment as a "phone" mode review, but the AM performance is so radically different from the comparison radios that I have to dedicate some space to discuss it separately. The Signature's demodulated AM audio is, in my opinion, not good; it simply sounds harsher and requires much more audio gain the most any radio that I have recently used. I found that the AM audio is so…disconcerting…to me that I would actually *have* to listen to AM stations (amateur or otherwise) via SSB.

The first question that comes to mind is…"why"? I don't have an answer for that, except to note that this, of course, a function of the DSP. I think the best that I can say about this today is that it will improve over time, as has every Flex Radio product that I have owned.

Companion video

A companion video has been created to illustrate the differences in audio spectrum between the various receivers. Please visithttp://youtu.be/4p9pWlKVvt0 to view the video. Please note that there may be, because of the difficulties in configuring Microsoft Windows audio subsystems, slight differences in the amplitude of the video audio. It is for this reason that the viewer should pay special attention to the PAA6 display, as every effort was made to feed the PAA6 with identical audio levels. The video was taken a high frame-rate, and it should be possible to single-step through key portions of the video so as to see the subtle differences between the radios, as seen on the spectrum analyzer's display.

Reviewer

N8MSA, Mike Alexander. You can read more about the reviewer's background using the link at the bottom of the review.

About the Reviewer

You can learn more about Mike [N8MSA] on the site at the link below:

http://n8msa.blogspot.com/