

The RTL-SDR.com 2.6MHz HPF Broadcast AM Reject Filter

by NNNBOC



The fine folks at RTL-SDR.com keep designing and releasing to market interesting, effective, and inexpensive doodads to aid the radio listener; from SDR receivers to FMBC notch filters, and now a new and very useful product. Note that I mentioned radio listener as opposed to SDR listener as many of these doodads can be used with just about any radio monitoring enthusiast's setup, SDR or not, just provide the required mating connectors, if needed, and off you go.

Today I'm evaluating their AMBC high pass filter, which greatly reduces energies below 2.6MHz coming from the antenna lead. This is desirable in cases where too much AMBC (and lower frequency) energies are impinging upon the radio input, perhaps creating intermod and spurs as well as reducing sensitivity in your receiver. The 2.6MHz cutoff frequency happily excises some of the second harmonic AMBC signals, which could be the strongest harmonics present and will be at twice the frequency of the AMBC stations in question.

Voiding warranty; you don't want to transmit through one of these filters, they're not designed for it and will fail and I don't want to see how many milliwatt it can take before it opens up.

In most of the USA as well as parts of Asia, Europe, North Africa, and the Middle East, one can receive very powerful AMBC signals; local ones during the daylight hours when D-layer ionization is greatest as the locals are at full output power to compensate, and much more distant AMBC stations at night after the/some local stations reduce power as the D-layer has dissipated and F-layer skip is coming in, along with the locally generated signals. Some stations are also required to modify their coverage pattern from what it normally is daytime, so as not to interfere with other stations at night.

As a point of interest, the reason all AMBC stations broadcast with a vertical antenna is vertical and very high angle polarization is least absorbed by the D-layer. The D-layer is created by overhead sunlight-excited ions in a region of the ionosphere up around the 40 to 55 mile mark. Think of it as a gaseous layer of undulating jello that eats radio waves. As most AM stations are only interested in covering a few miles to a hundred miles or so consistently, and knowing the D-layer eats all AMBC frequency signals that are not vertically polarized and/or have a low angle of radiation, this should also let you know that a vertically polarized antenna is best suited for local AMBC reception and is why most cars use a vertical antenna. This D-Layer is why you can't receive stations several hundred miles away during the day on the AMBC band but can at night. At night the D-layer itself dissipates and AMBC signals are reradiated by the much higher altitude F-layer, the F-layer is up about 90 to 300 miles in the ionosphere and is present at all times. The D-layer also eats low angle of radiation signals, meaning signals from further away are more attenuated as they pass through more of the D-layer itself.

AMBC stations use a high angle of radiation to increase their station's effectiveness in reaching local and fringe area listeners, a 1/4th wavelength vertical antenna satisfies pretty much all requirements for effective local daytime AMBC transmissions. Higher frequencies above the AMBC band are less and less attenuated by the D-layer until the D-layer has no consequence upon them and the F-layer takes over responsibility for radio propagation.

All this AMBC energy, local or distant in origin, daylight or in darkness, racing down our antenna lead to our receiver, could stand reduction in some listener cases. An external high pass filter with no diode junctions (diode switches are commonly used for switching different devices in and out of circuits) is optimal for use in the harshest rf environment as it can't contribute to imd via a nonlinear junction (i.e. diode) forced into rectification by strong rf, and is the prime reason a filter such as this is needed in the hobbyist market.

The RTL-SDR device employs sma connectors at each end, and ships with a male to male sma coupler so it interfaces with the commonly found RTL SDR sma inputs, perfectly threading to my RTL V3 and RSP2 SDRs both. This adapter is a nice touch as you don't have to order a jumper to use the filter, it comes included with the AMBC HPF for a very low price delivered to your door.

Another part of the rf spectrum that can be problematic to some radio hobbyists is all the crud from a few KHz up to and even beyond the AMBC band, most all of it is created in switching mode power supplies. Most electronic devices made today use a switcher power supply (either to operate the device or to charge its batteries) as switchers are more efficient and don't require the heavy (i.e. costly) transformer of a typical linear power supply at the same voltage and current ratings. One of the strongest and noisiest switcher power supply in many homes will be that of the desktop computer or laptop pc battery charger, only beaten out by the typical microwave oven or plasma tv set. Modern pc's often have very hungry cpus and video cards wich cause the psu to produce more power and hence more and/or greater spurs evenly spaced a few tens of kilo Hertz through the radio spectrum as the common frequency of switcher power supplies is from around 20KHz to a few hundred KHz, and they almost always produce harmonics. Also, some networking gear can emit trashy signals in the HPF's range via cat cable or psu so these unwanted signals can be excised too. It's nice to suppress all this noise at the source(s) and that should be attempted, but the AMBC HPF helps in this regard too.

So how does it work? Well, it's a rf filter consisting of passive components - inductors and capacitors - arranged in such a circuit so as to reduce rf energy below the cutoff frequency while allowing higher frequency energy to pass with little attenuation. You can google for example high and low pass filter circuits and their theory, I'll include some links at the bottom of this review for you. Of course you can build your own lowpass filter, but for the price and how elegant and professionally made this filter is, it can't be beat as far as I am concerned.

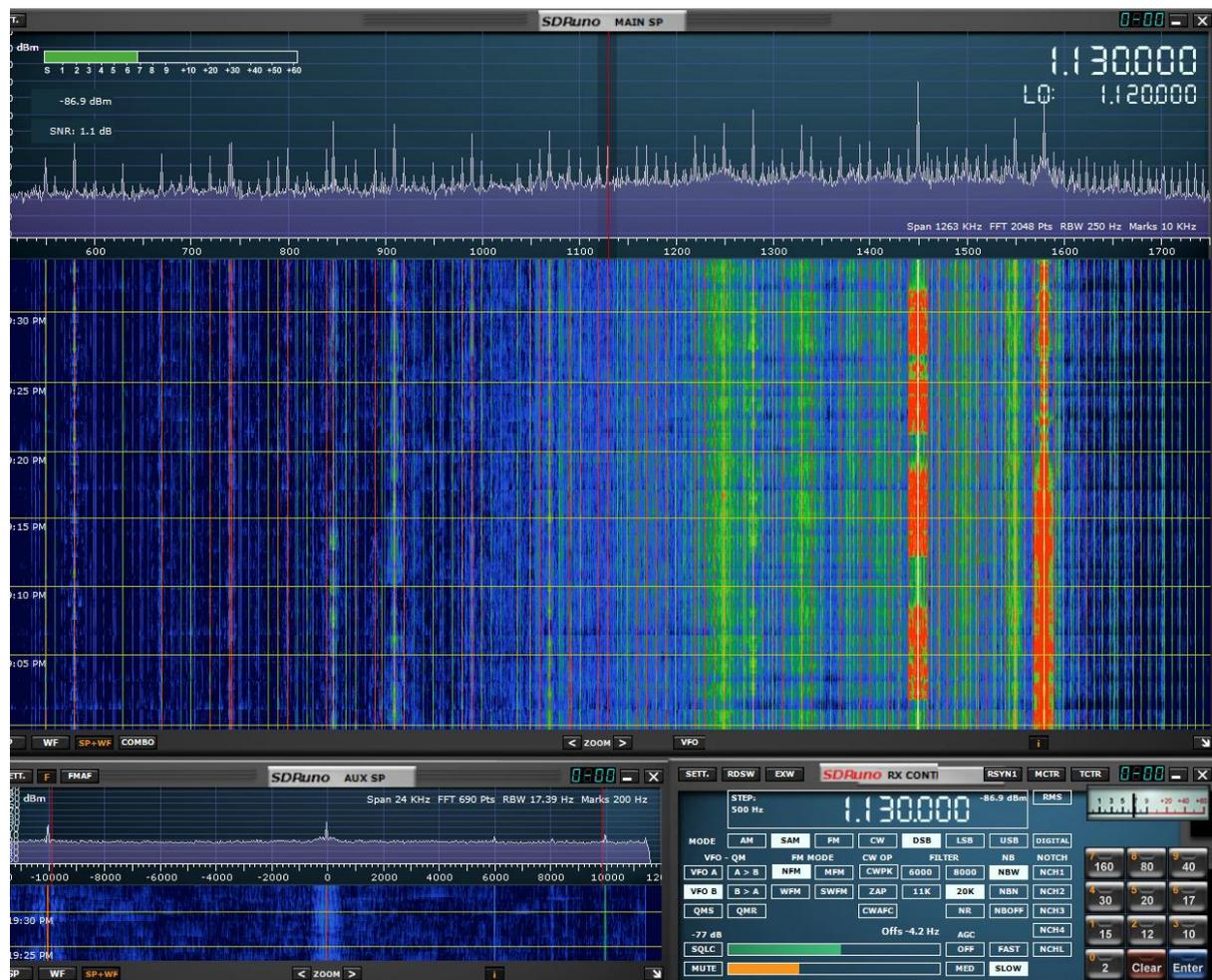
Needless to say, the target market for the AMBC HPF are those radio users who suffer from overload-induced dynamic range issues and/or the more intense rf environments experienced by those who are located within a few miles of an AMBC or other transmission site within the AMBC HPF frequency range, as well as those who have an antenna system that normally operates with large signals present such as amplified untuned loops and vertical antennas, and large wire antennas.

As an example of sufferers of unwanted high power radio signals, I know a radio enthusiast who has what I like to call a literal "wall" of very high quality JRC radios, and yes it is awe inspiring to behold. All are fed via an elaborate antennae patch panel to various antennas; from a 500ft loop at 40ft height to a RF Systems DX-One tower mounted loop to a multiband hf vertical and a few slopers thrown in. All of them fed with high quality coax and connectors professionally installed as he's a TV station engineer and HAM radio operator of several decades experience. By the way, out of all of those hf antennas he says nothing beats the 500ft loop at 40ft on HF and below, closely followed by the RF Systems DX-One - I know you were wondering. Throw in a Perseus SDR to top all those nice

JRC rigs off. All sounds very nice doesn't it? It is! Not only that, he also lives on some of the most conductive soil anywhere in the US.

So you're wondering where the hitch is in all this radio paradise, well, there's a rather large one; an AMBC station a few miles away that is so strong at his location during daytime, "only 25kw out days, 1kw night", that it saturates the front end diodes of his receivers - even the ones that are shut off. So, to enjoy radio bliss he has to reduce the signal levels reaching radios connected to any antenna and disconnect all radios not in use. He is a perfect candidate aka worst case scenario for this filter, even though his radios all have superior dynamic range. It only takes one tiny diode to rectify it into a mess. That's a serious contender for worst case radio scenario, but I've read about a guy who was a swl on the antenna plot of HCJB, like right next to the towers. A small \$14.95 black box not much larger in area than a postage stamp would ease the pain of several thousand dollars worth of antennae and shortwave sets, at the cost of greatly reduced signals below 2.6MHz when the filter's inline, a worthwhile trade in his case.

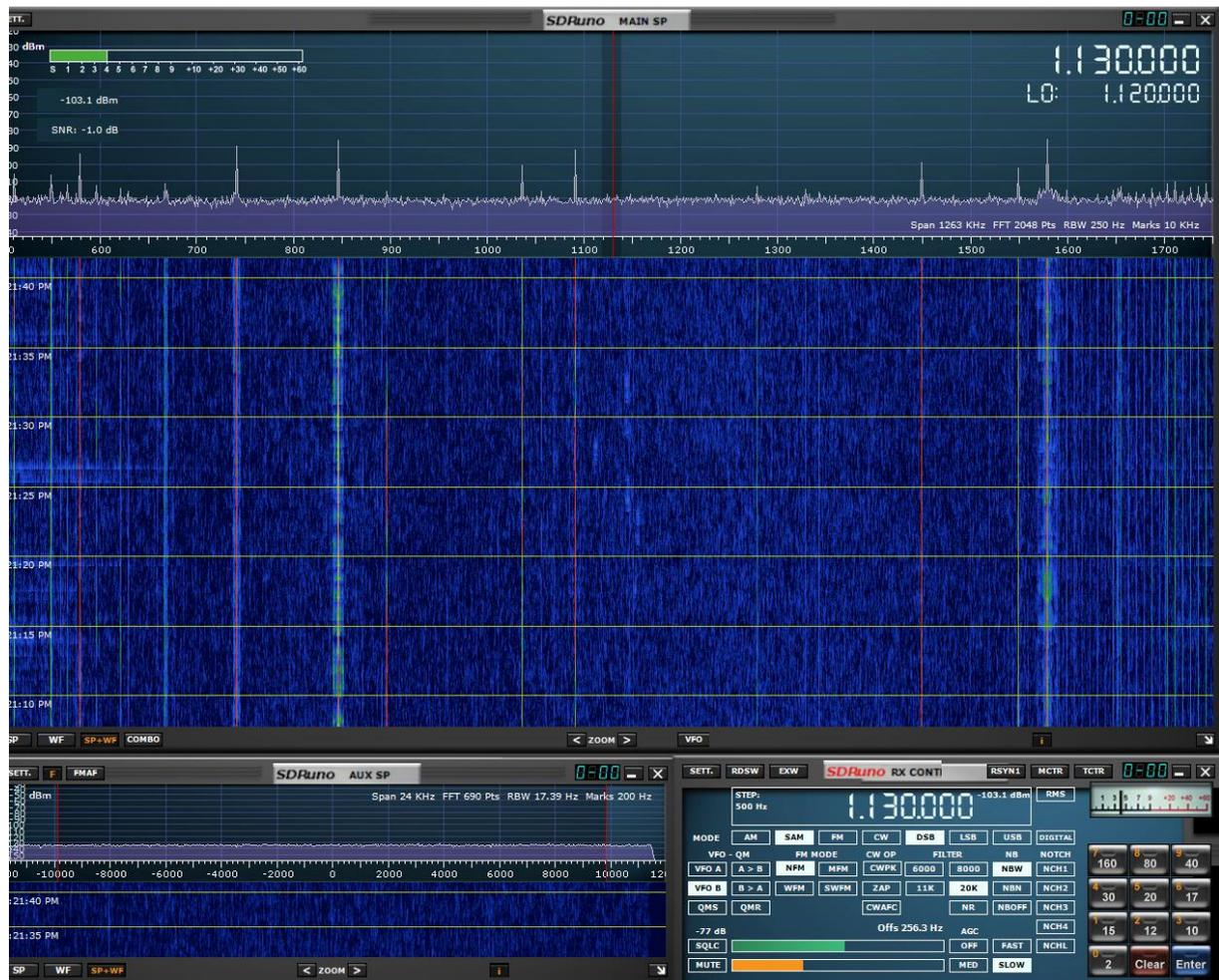
Anyway, my testing is being done not with a glorious wall of JRC radio but with the venerable RTL SDR V3 and SDRPlay RSP2. The V3 is quite suited to AMBC and HF work if used rationally, i.e. you take into consideration its limitations especially with regards to dynamic range and aliasing, and while the RSP2 is quite hardy at HF and includes a selectable AMBC notch itself, each SDR has various adjustments that can be made in the SDR app to fine tune the system gain and avoid imd spurs and aliases. In testing, these settings were adjusted to allow for optimal sensitivity without imd production or aliasing, no SDR application settings were changed between screenshots save for enabling the built-in AMBC notch filter of the RSP2 in the respective images.



Picture 1

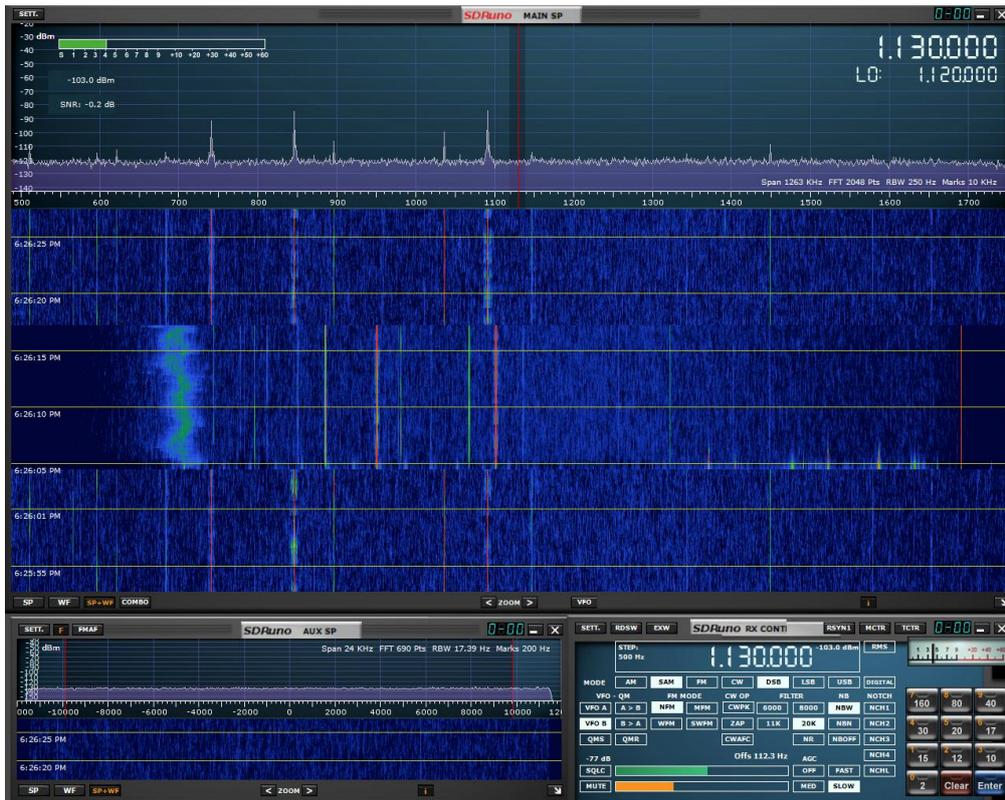
In the first pictorial example, RSP2 AMBC No AMBC Notch, we see the local AMBC spectrum as displayed by the RSP2 without any filtering. This spectrum includes the AMBC signals present as well as local noise sources such as pc and peripheral power supplies, usb bus noise, etc. You can easily listen to any signal in the band without distortion. This is the baseline for the AMBC spectrum for the RSP2 in my location.

In the second pic we see the RSP2 tuned to the same spectrum as before but with the built-in AMBC Notch activated in the control panel. You can easily see the AMBC signal levels are greatly attenuated and only the strongest locals as well as the noise signals from the pc and other home electronics is present.

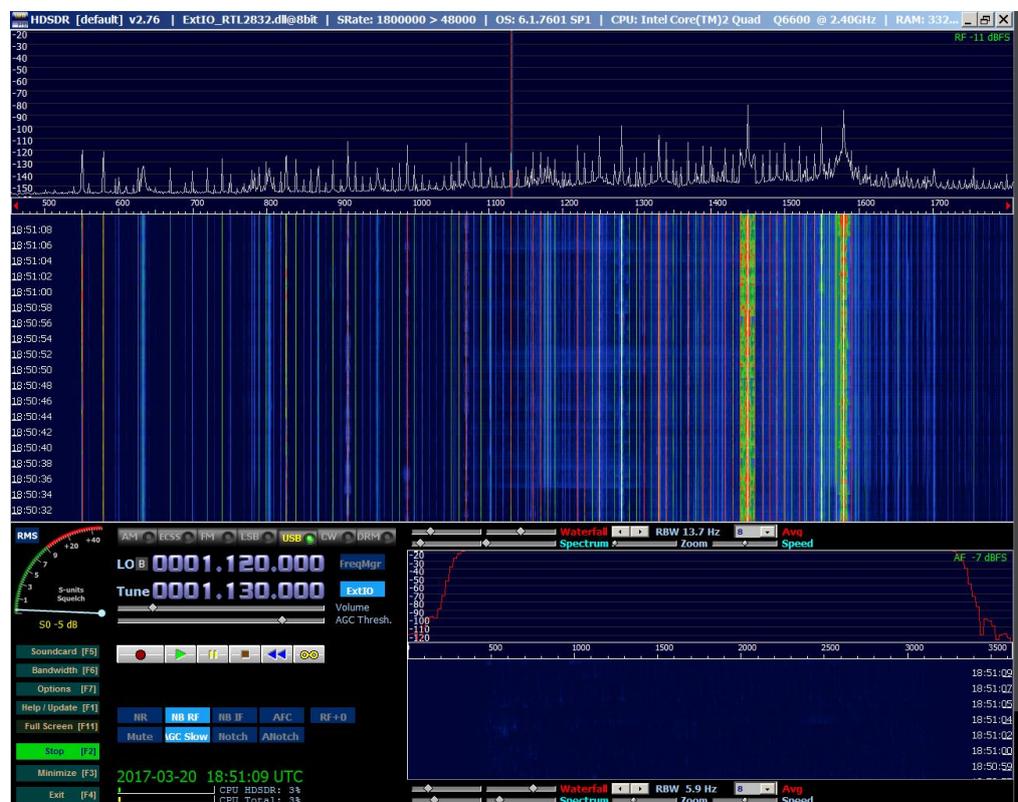


Picture 2

In the third pic we see the same RSP2 spectrum after the installation of the RTL SDR 2.6MHz HPF. In this pic we see the entire band and beyond is greatly attenuated, not even the strong local AMBC signals are present



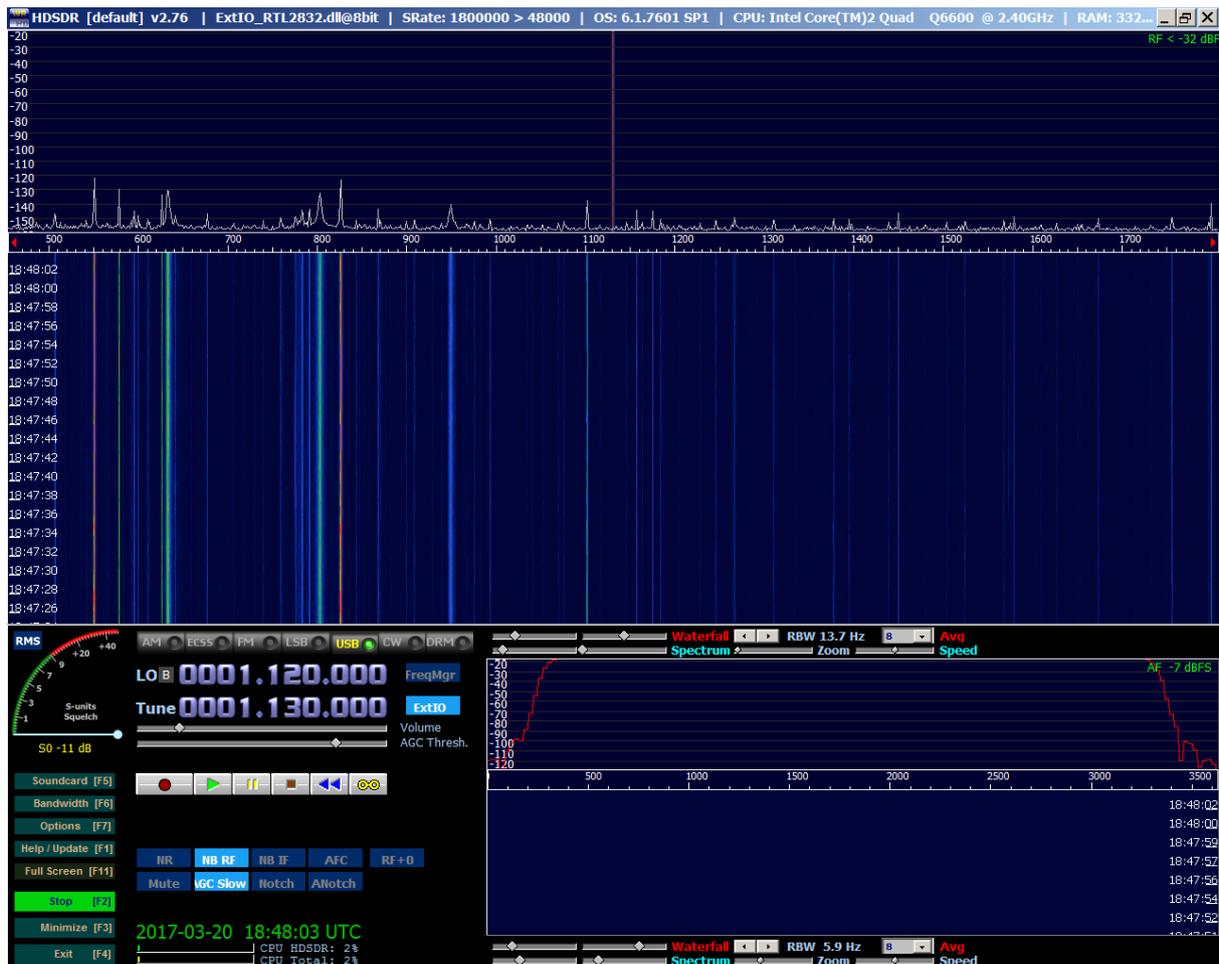
Picture 3



Picture 4

In the fourth pic we see the spectrum displayed by the RTL SDR V3 without filtering, the entire AMBC band is shown at full strength. The V3 has no built in AMBC filtering unlike the RSP2.

In the fifth pic we see the same spectrum as before but with all signals save for local pc noises more or less wiped out by the installation of the RTL-SDR HPF.



Picture 5

As you can see, the RTL-SDR AMBC 2.6MHz HPF works as designed and is perfectly suited to reducing LF/VLF/MW signal levels across the board without introducing intermod such as that caused by saturated diode junctions. This effect might allow one to increase gain while avoiding imd and alias issues that might be present when the filter is absent.

Related websites:

Get you a RTL-SDR AMBC HPF

<http://www.rtl-sdr.com/buy-rtl-sdr-dvb-t-dongles/>

Filter Design

<http://www.arrl.org/rf-and-af-filters>

Increasing your Ionospheric Layer Kung Fu

https://en.wikipedia.org/wiki/Ionosphere#F_layer