bhi ParaPro EQ20-DSP

The new bhi ParaPro EQ029-DSP provides versatile parametric filtering along with a 2-channel, 10 watts per channel, Class D power amplifier.

The unit has options that include bhi's digital signal processing (DSP) noise reduction filter along with Bluetooth connectivity, making the ParaPro EQ20 a sophisticated audio processing solution for all types of radio listening.

It is housed in a compact ABS case measuring 145mm (w) x 75mm (h) x 100mm (d) (including controls) and has plenty of connection options so it should be easy to integrate into just about any shack. Power requirement is the usual 12V DC power at up to 1.2A and this can come from the shack supply or the included 12V plug-top unit. Audio inputs are made using the three 3.5mm jacks on the rear panel. These provide channel 1 and 2 mono inputs or a combined stereo jack. All three inputs have been designed to cope with line or headphone level signals. The outputs comprise a set of banana sockets for the left and right speakers plus a pair of RCA phono jacks, also carrying the speaker output. One important point to note here is that the Class D bridge output has a direct DC connection to the amplifier circuitry (ie no isolating capacitors) so you must not parallel the speaker outputs or ground any of the connections. For headphone listeners, there is a 3.5mm stereo jack on the front panel. The Bluetooth version, reviewed here, adds Bluetooth connectivity into the mix with the ability to take input from a Bluetooth source and thus use the ParaPro EQ20 as a Bluetooth speaker.

Ways to adjust the audio

Let's start by explaining the difference between these three common methods of adjusting the frequency response of an audio system – Tone Control, Graphic Equaliser and Parametric Equaliser. The humble tone control is the simplest system and is usually configured to lift or cut bass or treble frequencies. The only adjustment provided is the amount of lift or cut but the frequencies acted upon are fixed.

A graphic equaliser, on the other hand, usually splits the spectrum into several fixed bands and provides lift and cut adjustment for each frequency band. However, the controls usually interact so if you lift one band you will often find that the adjacent bands are also lifted

PHOTO 1: The ParaPro EQ20 Audio DSP unit.

but to a lesser degree, **Figure 1**.

Parametric equalisers also split the audio range into bands but in this case, both the centre frequency of the band and the amount of lift and cut is adjustable. In a full parametric equaliser, the bandwidth of each band is also adjustable. Parametric equalisers exhibit far less interaction between adjacent bands and therefore make for more precise control.

The parametric filtering in the ParaPro EQ20 uses a slightly different approach as the filters act like two shelving filters, **Figures 2 & 3**. In those graphs, you can see that the boost or cut extends beyond the selected frequency giving the shelf-like curve.

Testing the ParaPro

Before using the ParaPro on-air, I carried out a few frequency response tests so I could better understand how the controls were operating. For these tests, I used the *HOLMImpuse*, freeware audio measurement tool. This is a very useful, general purpose, measurement tool that turns your PC into an audio sweep generator and spectrum analyser. The software can be downloaded from http://holmacoustics.com An important feature of the software is its built-in self-calibration that allows the characteristics of your soundcard to be subtracted from the measured result. That lets you clearly see the performance of the device under test (DUT). To handle the digital to analogue (and vice-versa) conversion I used a Mackie Onyx-Blackjack external USB soundcard. This unit is built like the proverbial brick outhouse, uses the excellent Cirrus Logic chipset, has 2 inputs and 2 outputs plus rotary level controls for input, output and headphone levels, **Photo 2**.

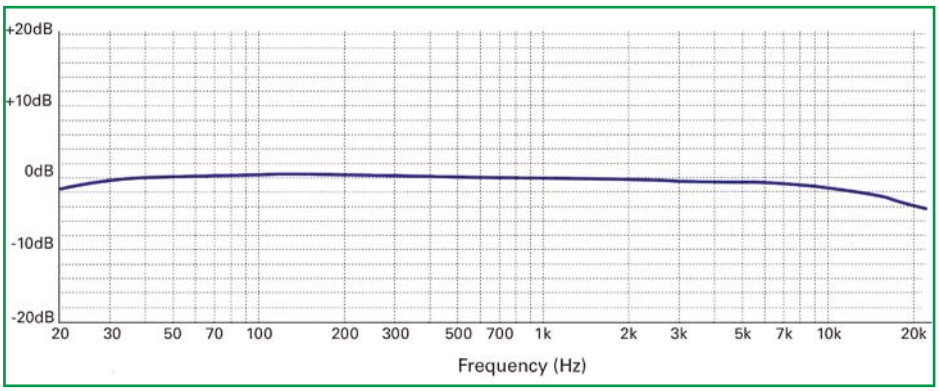

FIGURE 1: ParaPro EQ20 frequency response with the controls set for a flat response.

PHOTO 2: The sturdy Mackie Onyx-Blackjack external USB soundcard.

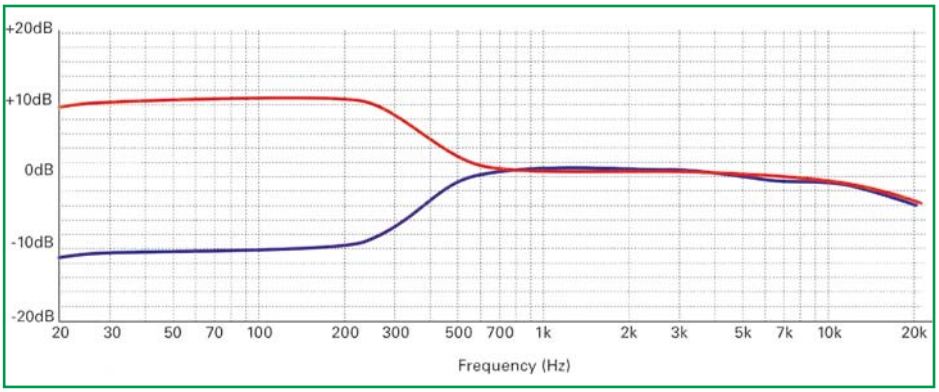

FIGURE 2: ParaPro EQ20 frequency response with the LF filter set to 300Hz +10dB (red) and -10dB (blue).

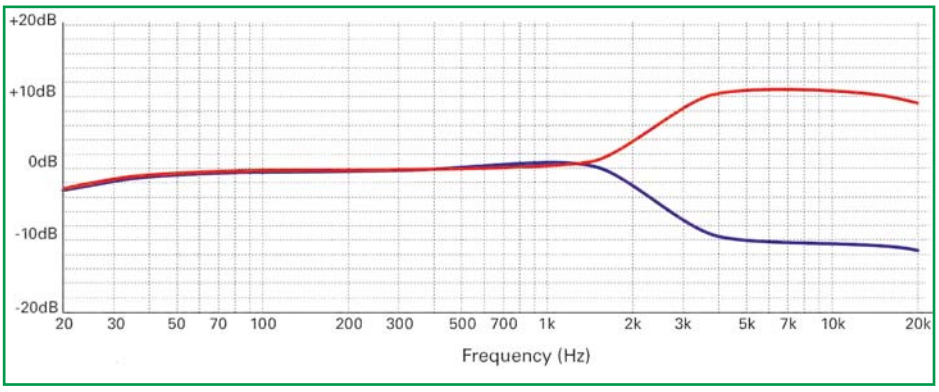

FIGURE 3: ParaPro EQ20 frequency response with the HF filter set to 3000Hz +10dB (red) and -10dB (blue).

As you can see from the photos, the ParaPro EQ20 has two parametric channels labelled Bass and Treble with the Bass centre frequency being adjustable from 100Hz to 1kHz, whilst the Treble covers 1kHz to 10kHz. Used together, these controls provide two bands of ±10dB adjustment from 100Hz through to 10kHz. In Figure 1, I've shown the frequency response of the ParaPro EQ20 with the equalisers set for a flat response and the noise reduction off. As you can see, other than a slight roll-off at the bottom end, the response is flat to within 1dB from 30Hz to 18kHz. The next test was to look at the available boost and cut with the Bass control set to 300Hz. I've shown the results in Figure 2. Here you can see a very well defined 10dB lift and cut without impacting on the response of the Treble range. In Figure 4, I set the Treble control to 3kHz and plotted the response with gain set to its ±10dB limits. This shows a similar well controlled response with good differentiation between the Bass and Treble controls. The panel controls for the Parametric equaliser were marked with a min and max value supplemented by ticks indicating increments of 100Hz for the Bass control and 1kHz for the Treble control, see **Photo 3**. I decided to take a few measurements to see how well these tracked. I was pleasantly surprised to find the markings remarkably accurate. In each case, the selected frequency exhibited a lift or cut that was half the selected lift or cut, ie if I set the Treble to 5kHz and the lift to 10dB, 5kHz would be lifted by 5dB.

When the DSP noise filter is switched in, the response changes significantly because the noise filter is a primarily a speech-band device, so allowing frequencies up to 20kHz would only add to the noise. The DSP Noise Filter in the ParaPro EQ20 is continuously variable from off to full noise reduction. To show the impact on the frequency response, I measured the response with the noise reduction control set to the mid-point. The result is shown in **Figure 4**, where you can clearly see the passband shaping. The parametric equalisation still works with the DSP noise filter active but its only effective over the narrower frequency range of the DSP Noise Filter.

On the Air

For the on-air tests, I used the ParaPro EQ20 with several computer based software defined radio (SDR) receivers plus a Yaesu FT-897 transceiver. For the audio source, I used either the headphone output socket or the line out from the computer. The input selection on the ParaPro EQ20 is managed via a small button on the front panel that cycles the input selection through the available options. On the review model, these were CH1, CH2, Stereo or Bluetooth with the selection indicated by a light emitting diode (LED). This LED served a secondary role as a clipping indicator where the LED would flash if the input signal was too high. The facility to select single channel or stereo mode is useful for SDR operators as you could use multiple virtual receivers with their outputs routed to different channels. For example, if you were running an SDR with 3 virtual receivers, you could send one to CH1, a second to CH2 and place the third on both channels. That way, if the sound comes from the left its receiver 1, the right and its receiver 2 and the centre for receiver 3.

The first challenge for the ParaPro EQ20 was some mid-morning listening on 14MHz

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PHOTO 3: Close-up view of the filter control panel.

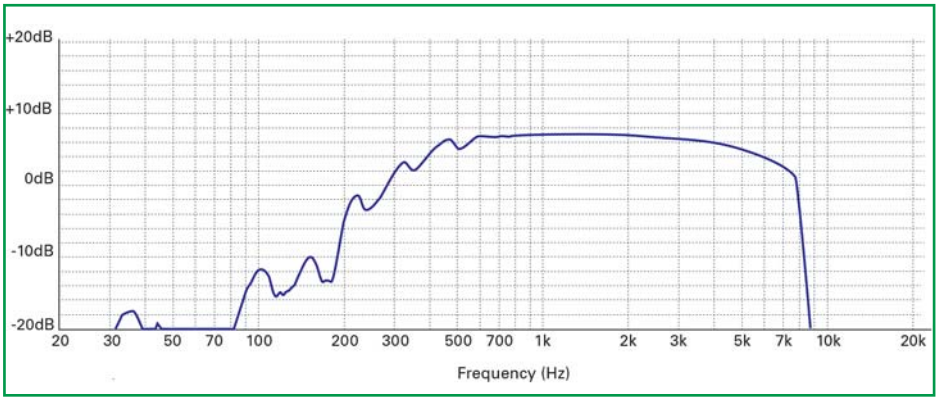

FIGURE 4: ParaPro EQ20 frequency response with the DSP noise filter set to mid-point.

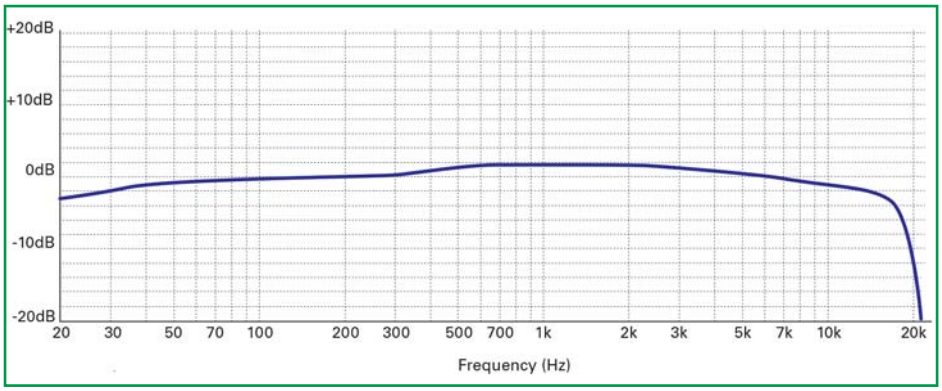

FIGURE 5: ParaPro EQ20 frequency response via the Bluetooth link.

when conditions were flat and everything was noisy. I started by setting the Bass equaliser at -10dB and then adjusting the Bass frequency upwards from 100Hz to reduce the low frequency roar. Once that was done, I turned to the Treble control, set it to -10dB and tuned it down from 10kHz until the speech started to deteriorate then backed off a bit. That produced a significant improvement over the unfiltered audio so I tried using some Treble boost to see if that would help. I soon found that setting the boost to +10dB and tuning up from 1kHz helped the intelligibility more than just using the filter to cut the higher frequencies. The boost setting gave some very useful mid-range punch that helped readability. Once I'd used the level settings at their extreme I refined the filtering using the frequency and lift/cut controls.

The next test was to use the same signal to evaluate the DSP noise reduction. I soon found that the best setting seemed to be mid-point on the rotary control as it produced very effective noise reduction without introducing the robotic and watery sounds that characterise many DSP noise reduction systems. With the noise reduction set, I then experimented with the Treble and Bass controls. As mentioned earlier, the effective control range is much narrower due to the frequency shaping of the DSP noise reduction. I used the same techniques as before and they worked very well to provide a significant improvement over the original, unprocessed signal. By combining the filtering and noise reduction I could convert an unpleasantly noisy signal into comfortable listening. As audio quality is so subjective, I've made some recordings of one of the test signals so you can hear the results for yourself. These can be found at http://photobyte.org/bhi-parapro-eq20-dsp-sound-file/

When I used the filter for some 80m local QSOs with relatively strong signals I found the same adjustment techniques worked but best results came with less severe use of the cut/lift controls. Just to complete the picture, I used the ParaPro EQ20 for some broadcast band listening and the Treble/Bass controls worked well to make the most of the prevailing conditions. When signals were good I employed a bit of boost at both ends of the spectrum to deliver a more natural sound.

One slightly unusual use of the DSP noise filter was as an audio squelch. This was particularly useful on VHF and overcame the problem of missing weak signals that are below the traditional squelch threshold. This worked well for keeping an eye on VHF calling channels and air band signals.

Bluetooth

Including Bluetooth connectivity is a very useful option and opens up a host of additional uses for the ParaPro. Those with PC based SDR receivers need only add a simple Bluetooth dongle (£2 - £10 from Amazon) to enable a wireless connection between their computer and the ParaPro. Setting-up the Bluetooth link was very straightforward as you just set the ParaPro EQ20 source selection to Bluetooth, go the Bluetooth panel on your PC, locate the ParaPro EQ20 and hit connect. Once you've made the initial connection, the PC remembers the device and will automatically connect when it's within range. You can also use the ParaPro EQ20 as a Bluetooth speaker with other Bluetooth enabled devices such as mobile phones, tablets and laptop PCs. With this wider use in mind, I was interested to see how the frequency response held-up when measured through the Bluetooth connection. To do this, I used HOLMImpuse software I mentioned earlier but with the input to the ParaPro EQ20 routed via the Bluetooth link. This worked very well and gave a response that was within 3dB between 20Hz and about 18kHz, **Figure 5**.

Summary

The ParaPro EQ20 builds on bhi's comprehensive range of audio processing solutions and provides some powerful, yet easy to use audio processing. The parametric equaliser works particularly well and the tuning and lift/cut range is about right. I was very impressed with the DSP noise filter as it manages to achieve good levels of noise reduction without adding the unpleasant artefacts so often associated with DSP noise reduction. The addition of Bluetooth capabilities is very welcome and expands the range of applications for the ParaPro EQ20.

The ParaPro EQ20 Audio DSP unit is available direct from bhi (www.bhi-ltd.com) and can be found at other popular radio suppliers. It ranges in price from £159.99 to £299.95 depending on the optional extras. My thanks to bhi for the loan of the review model.