

Mike Richards looks at two products from bhi Ltd. that feature a new and improved noise elimination algorithm.

bhi Compact In-Line and Dual In-Line Noise Elimination Modules

bhi Ltd. has been producing noise elimination modules since 2002 and has built-up a comprehensive range of products based around their specialist noise cancellation module. The two units reviewed here are the first to feature a new and improved noise elimination algorithm. Although the two units reviewed here employ the same dual-channel noise reduction algorithm, the products are aimed at different sectors of the market. The Compact In-Line is a small, portable unit that can be powered by a pair of internally mounted AA cells or from an external 8 to 16V DC power supply. This is ideal for use in a smaller installation or when away from home. On the other hand, the Dual In-Line is intended more for base station or mobile operation and features a healthy 7W mono power amplifier. The Dual In-Line also includes a separately controlled Line out and a dedicated headphone amplifier.

Noise Reduction Techniques

Over the years, many types of noise reduction systems have been developed and the key to any successful system is being able to differentiate the human voice from the noise. There are many

approaches to this but the method used in the bhi modules is to examine the frequency spectrum between 0.6 and 6Hz. You might be thinking, why look at those frequencies when communications speech normally uses 300Hz to 3kHz? While it's true that the normal speech-band does carry the main energy content of the human voice, the bhi method uses the modulation of the sound to detect the human voice. When we speak, we form words by modulating the tones from our vocal chords, using the combined movement of our mouth and tongue. It is this modulation of the vocal tones that occurs in the 0.6 to 6Hz band and is used by the voice detection algorithm. In the practical designs reviewed here, the speech band is divided into a number of sub-bands that are each examined for the presence of voice modulation. Bands showing voice modulation are allowed to pass unhindered, while others are attenuated. The degree of noise elimination is adjusted using an eight-step switch.

Compact In-Line Connections

The Compact In-Line is housed in a neat ABS case measuring just 126 x 70 x 38mm. All the connections are located on

the right-hand side, which helps to keep the cabling tidy. I've shown a simplified block diagram of the Compact In-Line in Fig. 1, along with a typical connection setup in Fig. 2.

The Compact In-Line can take its dual-channel input from either an external speaker jack or the Line level output from your receivers. When using the Speaker input, the Compact In-Line supplies a 7Ω load to ensure that the input is properly terminated. The Line level input is very versatile and can handle a wide range of inputs up to 1.6V peak-to-peak.

The Compact In-Line has a stereo/dual channel output, which is routed to the 3.5mm headphone (Phones) jack. Although marked for Phones, this output can also be used as a Line level feed for powered speakers.

The power requirement was 8 to 16V DC, with a nominal consumption of 30mA but this can peak to 350mA if you are driving low impedance headphones. A 1.3mm coaxial power socket and fused 1.2m DC power lead was included for use when running the Compact In-Line from an external power source.

When using battery power, the Compact In-Line requires two AA cells and the battery life is expected to be around 40 hours when using typical 2,500mAh alkaline or nickel-metal



The bhi Dual In-Line and Compact In-Line noise eliminating modules.

hydride (NiMH) cells. To help extend the battery life, the Compact In-Line includes a useful battery saver routine. This monitors the input signal level and if the signal level remains below 60mV peak-to-peak for 60 minutes, the Compact In-Line will power down automatically. The Compact In-Line's supply was well regulated and inductor/capacitor (LC) RF filtering was fitted to all inputs and outputs.

Compact In-Line Operation

As you can see from the photographs, the Compact In-Line has just two rotary controls, both of which used continuously rotating shaft encoders with 18 clicks per revolution. These controls also had a push-click action.

The Compact In-Line is powered-up by clicking the Power/Volume control, which also illuminates the light emitting diode (LED) status indicator on the top panel. The Status indicator employed a multi-colour LED with green indicating Filter On, orange indicating Filter Off, red indicating Low Battery and a flashing LED warned of an input Signal Overload. The second rotary control provided access to the noise elimination filter, with the push-click action toggling the Filter Level On-Off. The filter was provided with eight settings, which gradually increased the degree of noise elimination. As the control was a continuous rotation type, the degree of noise elimination was indicated by beeps injected into the audio output. Each clockwise click of the knob increased the filter effect and was indicated by an increasing beep frequency until the eighth step was reached. Conversely, counter-clockwise movement reduced the effect with decreasing beep frequency. Once I got used to the system, it worked well, though to reach a particular setting, I had to turn the knob to one extreme and count back. Once the required level had been set, the Compact In-Line remembered this and I could toggle the effect on/off without losing the setting. The flashing LED Signal Overload warning was very useful but it caught me out the first time I used it because, when triggered, it keeps flashing for three seconds, even if the overload condition is removed.

Compact In-Line Performance

The noise reduction performance of the new algorithm is very good and I think it is an improvement over the original

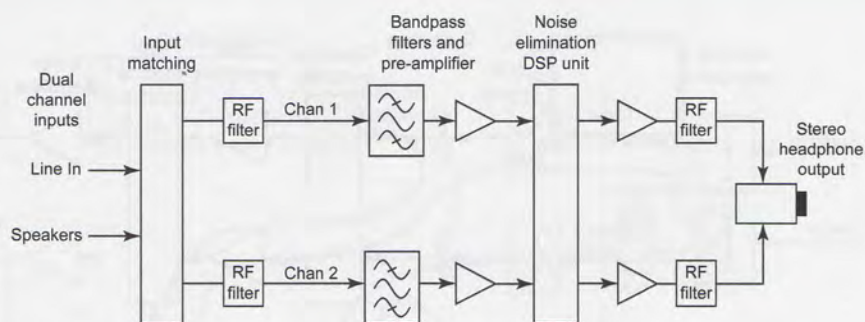


Fig. 1: bhi Compact In-Line block diagram.

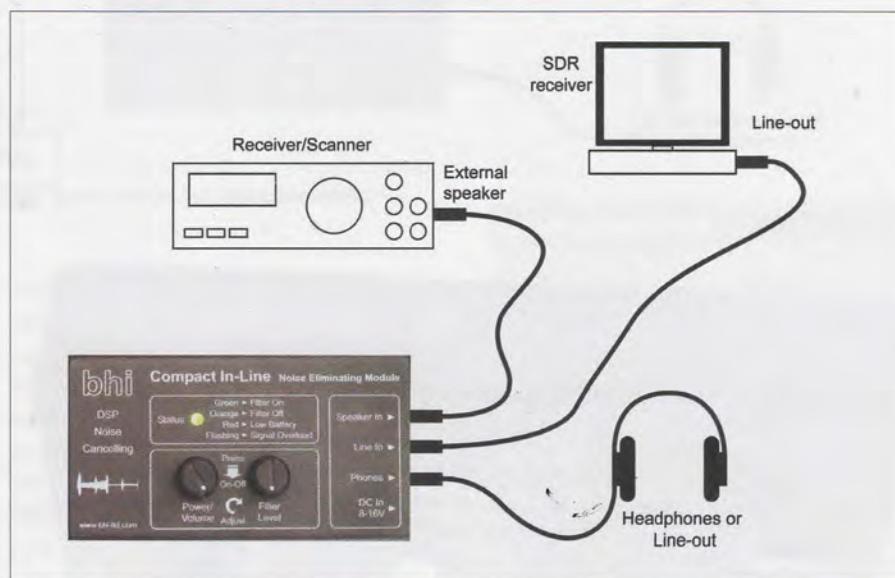
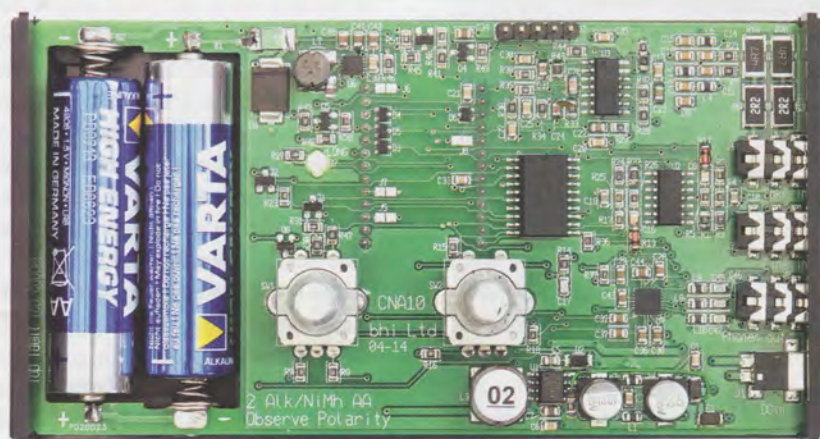
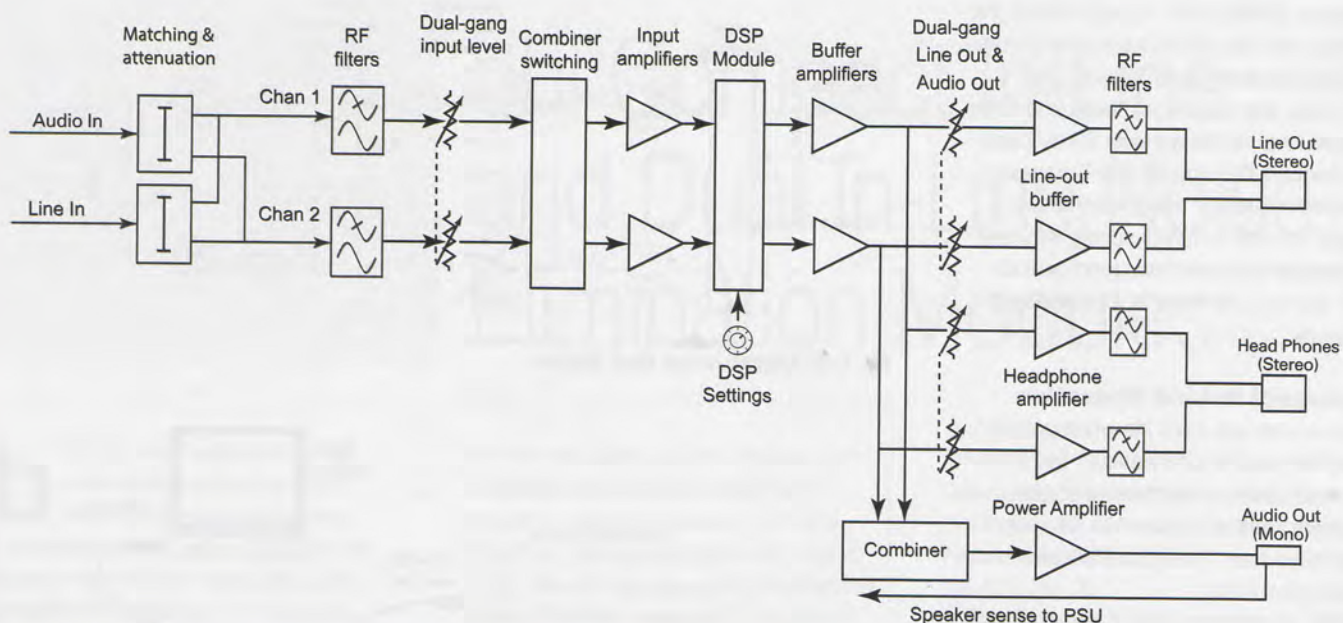


Fig. 2: The bhi Compact In-Line connection options.



An inside view of the bhi Compact In-Line Noise Elimination Module.

The bhi Compact In-Line Noise Elimination Module.



The bhi Dual In-Line Noise Elimination Module.

version. I wasn't able to undertake direct A:B comparisons with an older unit but it certainly sounded good to me. As it's difficult to describe the noise reduction improvement, I've made some recordings using the Compact In-Line with a variety of settings and you can access them via the following link.

<http://goo.gl/qyRpBm>

The range of noise elimination settings was well chosen and I found the most useful effect occurred in the mid-range settings between 2 and 6. I also found that the optimum noise elimination setting depended very much on the strength and clarity of the received signal. When receiving strong signals, I could wind-up the noise setting with minimal processing artefacts. However, when listening to marginal signals, I had to use the lower noise elimination settings to avoid watery artefacts. This was logical because the voice detection algorithm would find it easier to detect the human voice in a strong signal, so it would produce more accurate noise

elimination. The Compact In-Line's volume control step size was fine, other than each step producing an audible click in the output. A novel addition was the use of low, medium and high level settings that were toggled by clicking the volume knob.

Dual In-Line Connections

The Dual In-Line's ABS case measures 166 x 79 x 49mm and is supplied with a 1.2m DC power cable terminated with a 2.1mm coaxial power plug at one end and tinned wires at the other end ready for connection to your power supply. The power requirements were 10 to 16V DC at 500mA and the Dual In-Line includes power supply filtering and regulation, so the supply quality is not overly critical.

As you can see in Fig. 3, the Dual In-Line has a comprehensive selection of inputs and outputs. For the input connection, it has a standard Line In and an Audio In. The Line In can handle Line level inputs up to 0.6V peak-to-peak, so should be fine with most receivers. The

Audio In jack has been designed for use with the external speaker output of your receiver and includes a low impedance terminating load.

The Dual In-Line has three signal output jacks starting with the Line Out, which is intended for use with powered speakers or other Line level devices. The Audio Out provides up to 7W of mono audio and has a combiner network fitted ahead of the amplifier to mix the two-channel audio into a mono feed. The amplifier output was supplied to a 3.5mm jack that had an ingenious protection switch. This switch kept the power amplifier muted unless a mono jack was plugged into the Audio Out jack. If you inadvertently connect a stereo headphone to this jack, the amplifier won't power-up. Finally, there was a dedicated headphone (Head Phones) output with its own driver amplifier. The Line Out featured its own level control, while the speaker and headphone outputs shared a common level control. As with the Compact In-Line, all inputs and outputs were fitted with LC RF filtering.

Dual In-Line Operation

The two channels of the Dual In-Line can be used for stereo noise reduction of voice signals but the design is really intended for use with either two separate receivers or a pair of receive channels from a multi-channel software defined radio (SDR) receive system. However, it can be used with a mono input and a mono speaker on the output. I've shown a typical interconnection to a dual receiver SDR system in Fig. 4.

When used in this configuration, you can monitor two separate receive channels with the outputs routed to the left and right channels. You can then easily detect the active channel by the position of the sound – the left or right channels. While the Dual In-Line provides two separate channels of noise elimination, all the controls are dual-gang, which means that you cannot independently alter the volume or noise elimination setting for each channel. In practice, this is not a problem because multi-channel SDR systems have independent output level controls so that any level balancing can be done at that point.

As with the Compact In-Line, the Dual In-Line included an input overload indicator in the form of an LED that flashed if the overload threshold was breached.

Noise elimination setting on the Dual In-Line used a 10-position rotary switch of which only positions 1 to 8 were used. As you can see from the photos, the noise eliminating settings were clearly marked.

Dual In-Line Performance

As mentioned earlier, the Dual In-Line is best suited for use in larger receive stations and will no doubt find favour with club, competition, demonstration and DX stations. The overload indicator on the Dual In-Line was more helpful than the three-second flash of the Compact In-Line and the provision of separate indicators for each channel was a good move. As with the Compact In-Line, the noise reduction performance was best between settings 2 and 6, with the higher settings more effective on stronger signals.

Noise Elimination Recordings

To help you appreciate the effectiveness of the bhi noise elimination modules, I've posted a few recordings on my website. The recordings were made using a

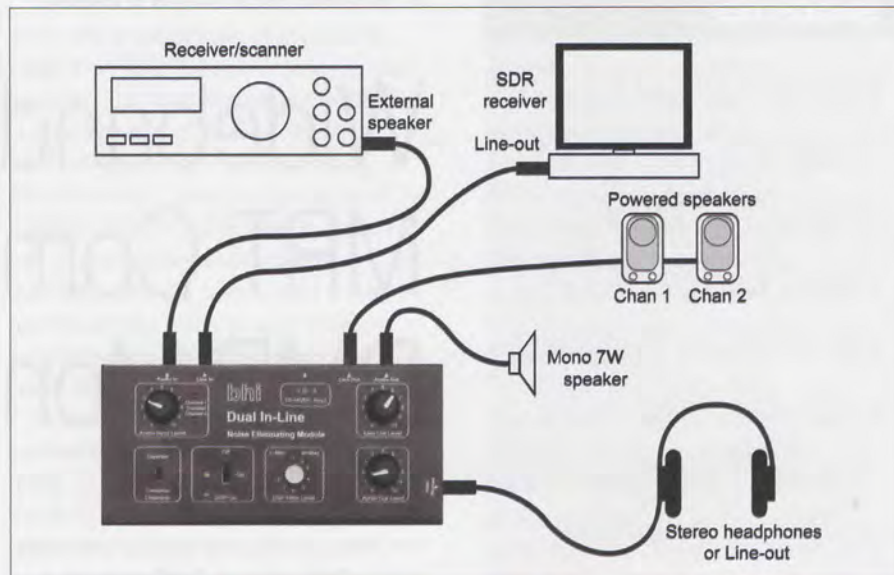


Fig. 4: bhi Dual In-Line connection options.

FUNcube Dongle Pro+ working with SDR# and tuned to Prestwick VOLMET on 5.45MHz. An in-phase and quadrature (IQ) recording was made of a 180kHz wide chunk of spectrum and played back in a loop using SDR#. The audio output from SDR# was routed via my M-Audio Delta 44 soundcard and used to feed the Line In connector of the noise elimination unit. The Phones output from the Compact In-Line and Line Out from the Dual In-Line were then connected to an input of the Delta-44 soundcard and the signal was recorded using the excellent Audacity open source audio editor. The recordings were then exported as MP3 files and posted on the web. In each case, the recorded files contain 10 seconds of untreated signal followed by 10 seconds of processed signal at the indicated setting. This sequence is then repeated once, giving a total recording duration of about 40 seconds per sample. You can access the recordings via the following link.

<http://goo.gl/qyRpBm>

conclusion

The noise elimination achieved with the bhi units was very worthwhile and both were very easy to use. As its name suggests, the Compact In-Line is very compact and the integrated battery power facility makes it ideal for use on holiday or when out for a spot of hilltop listening. On the other hand, the Dual In-Line is more of a base station unit and its 7W output should be plenty for any shack.

At the time of writing, the Compact In-Line costs £179.95 and the Dual In-Line (rrp £229.00) was on special offer at £199.00. Both modules are available directly from bhi Ltd. or from many of the *RadioUser* advertisers. **bhi Ltd., 22 Woolven Close, Burgess Hill, West Sussex RH15 9RR.**

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My thanks to bhi Ltd. for the loan of both models and for their technical support during the review.

Specification Highlights

Item	Compact In-Line	Dual In-Line
Inputs: Speaker-in/Audio In	7Ω, 2W maximum	8Ω, 2W maximum
Inputs: Line In	7kΩ 1.6V peak-to-peak	10kΩ 600mV peak-to-peak
Outputs: Phones / Head Phones	0.2 watts in >4Ω	0.5W in 8Ω stereo
Outputs: Audio Out (mono speaker)	N/A	7W into 8Ω mono
Outputs: Line Out	N/A	0dBV in 600Ω
Noise Elimination levels	1 to 8 (9dB to 35dB)	1 to 8 (9dB to 35dB)
Power supply: External	8 to 16V 350mA peak	10 to 16V DC 500mA peak
Power supply: Batteries	2 x AA alkaline or NiMH	N/A