

# bhi Dual In-Line Module

## The latest 7 watt stereo/dual channel DSP noise eliminating in-line module



Front view of the new bhi Dual In-Line Noise Eliminating Module.

**NOISE REDUCTION.** bhi have specialised in the manufacture of noise reduction units for the amateur and commercial radio markets for many years and are well respected in this area. The bhi Dual In-Line is the latest offering and employs their new, improved, noise reduction algorithm. The Dual In-Line name derives from the fact that it is a dual channel device so can be used for stereo noise reduction or for providing noise reduction on two separate channels.

**IN THE BOX AND CONNECTIONS.** The Dual In-Line is supplied in a neat ABS case measuring just 167 x 79 x 48mm. In addition to the unit itself, there was a fused power cable with a 2.1mm coaxial power connector at one end and tinned wires at the other ready to connect to the shack 12V power supply. The supply voltage range was 10-16V and the Dual In-Line includes on-board regulation and filtering so just about any DC supply in the 10-16V range could be employed. The supply current consumption

depends very much on how the Dual In-Line is used and ranged from approximately 50mA when using headphones to as much as 500mA when driving an external speaker at full power. The Dual In-Line is positively bristling with connectors that include line-in, audio-in, line-out, audio-out and a stereo headphone jack – more on these later. All audio connections used popular 3.5mm stereo jacks.

**bhi NOISE REDUCTION SYSTEM.**

Although the Dual In-Line uses a new noise reduction algorithm, the principles employed remain similar to their earlier products. To differentiate human speech in the input signal, bhi analyse the incoming audio spectrum between 0.6Hz and 6Hz. This may seem a bit odd as we all know that communication voice signals normally occupy the 300Hz to 3kHz band. However, when we speak, we modulate the sound generated in our voicebox using our mouth and tongue. It is these modulations that occur in the 0.6Hz to 6Hz range and so prove a useful way to differentiate human speech from other forms of noise. In addition to detecting voice modulation, the bhi system splits the communications audio spectrum into a number of sub-bands. Each of these are analysed for the presence of speech modulation and are either suppressed or allowed to pass through. As with most bhi noise reduction systems the amount of noise reduction is adjustable and the Dual In-Line has 8 pre-set steps available.

**INSIDE THE DUAL IN-LINE.** As usual, bhi have been very cooperative during the review and allowed me sight of the full circuit diagrams. I have shown a simplified block diagram of the Dual In-Line in Figure 1. As

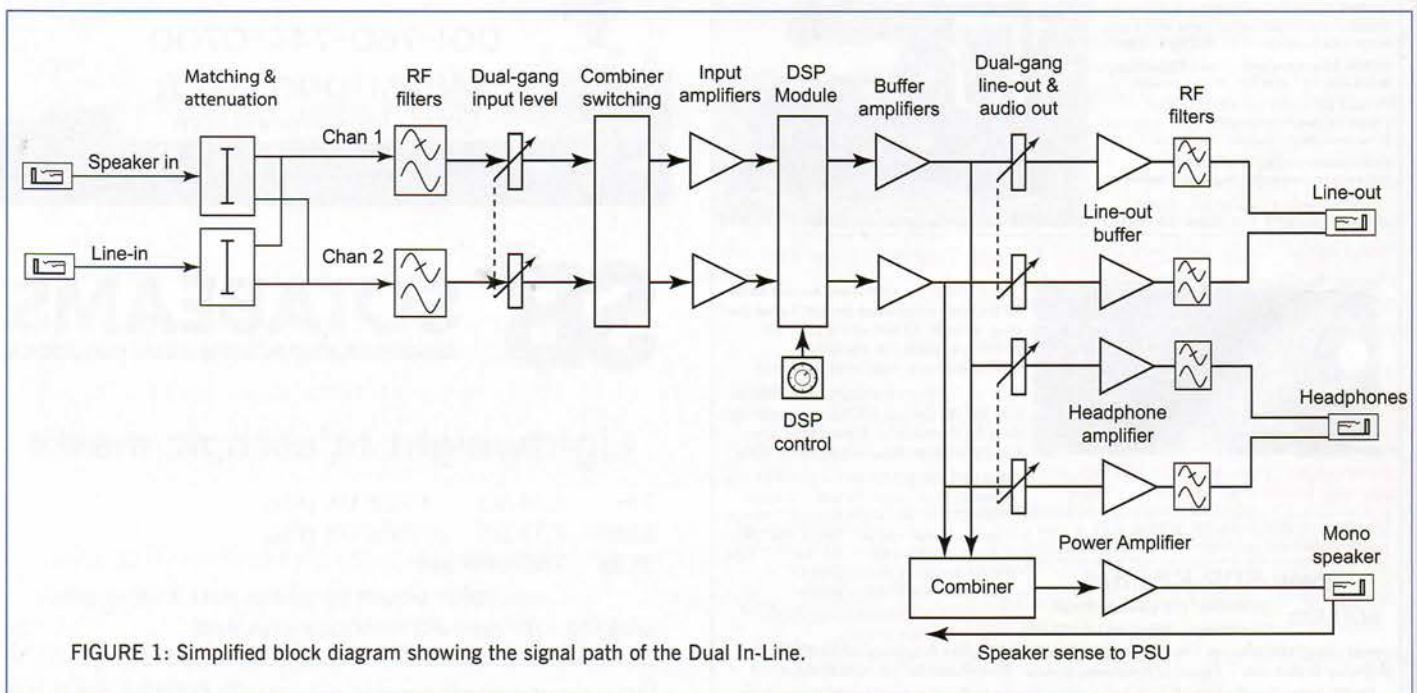


FIGURE 1: Simplified block diagram showing the signal path of the Dual In-Line.





Front view of the bhi Dual In-Line with connectors in place.

you can see, it is a fairly sophisticated device, so let's take a closer look. The stereo/2-channel input signal from the radio can be supplied either at line level to the line-in jack or from the rig's external speaker jack using the speaker-in jack that can handle up to 2W of audio. The speaker-in jack provides a low impedance resistive load to ensure the rig's audio stage is properly terminated, whilst the line-in jack presents a 10kΩ impedance load that is ideal for low level signals. The signal from each input channel is attenuated and passed via an RF filter to the dual-gang input level control. The signal is then fed to the switched combiner circuit that allows both channels to either be kept separate or combined into a dual channel mono signal. A dual buffer amplifier follows and this is used to feed the two channels to the specialist digital signal processing (DSP) module. The output of the buffer amplifiers also feeds an active audio overload circuit that drives a pair of red LEDs. These LEDs are mounted next to the input level control and flash to warn if the input signal is too high. In normal operation the input level should be adjusted so that the LEDs remain extinguished. The DSP module is controlled by an 8-position rotary switch to set the different degrees of noise reduction. The output of the DSP module is applied to a pair

of buffer amplifiers, where the output is split to feed two dual-gang potentiometers. One path feeds a pair of line-out buffer amplifiers that supply the signal to the line-out socket. The other dual-gang potentiometer feeds a stereo headphone amplifier and a combining network that drives the mono speaker output. It was good to see dedicated headphone and speaker amplifiers included in the design along with a very healthy 6 watts of audio for the speaker.

The power supply featured an internal fuse along with diode reverse polarity protection and RF filtering. Although the Dual In-Line is mounted in an ABS box, all inputs and outputs were fitted with good quality LC RF filtering to minimise the risk of RF entering the signal path.

**CONNECTING UP.** The Dual In-Line is bristling with connections, see **Figure 2**, so let's look at how they should be used. There are two 3.5mm input jacks with the audio-in configured to accept a signal from the external speaker jack of your rig. As mentioned earlier, this is terminated with a low resistance load. Don't make the same mistake I did of connecting the line-out of your receiver to this jack or you will end up with very weak and distorted audio! The line-in jack is used for line level audio input from the line-out or record-out connections on your rig. The power connection is straightforward and well protected with wire ends to connect to the shack 12V supply. The use of a standard 2.1mm power jack means that you could easily power the Dual In-Line with a wall-wart or plug-top 12V DC supply. A 100mA unit will be fine if it's to be only used with headphones but if you're intending to drive an external speaker you will probably need a 500mA unit.

The output from the Dual In-Line is simultaneously applied to three separate 3.5mm jacks. The line-out jack provides a line level output signal with the level being controlled by the line-out potentiometer on the front panel. However, the audio out and headphone volume is controlled by the Audio Out level control on the front panel. Although controlled by the same potentiometer, these two outputs have separate driver amplifiers with the audio-out designed to drive an 8Ω external speaker with a very respectable 6 watts of audio. One point to note is that the two stereo channels are combined into a mono speaker output whilst the headphone output remains as two separate channels. To avoid damaging your ears by accidentally plugging your headphones into the speaker jack, bhi have implemented a very neat solution. Although the speaker jack is a 3.5mm stereo unit the ring connection is used to mute the power amplifier. If you insert a correct, mono, 3.5mm speaker jack the amplifier will power-up and drive the speaker. However, if you insert a stereo jack the amplifier will remain muted.

**OPERATION.** Some of you may be wondering why you would want a stereo noise reduction unit when amateur radio rigs are primarily mono devices. One answer comes from the increasing use of SDR receivers in the shack. Many modern SDR receivers include two or more receive chains so you can actively monitor multiple frequencies. Whilst most of us would find difficulty listening to two conversations simultaneously, it is perfectly feasible to carry on a QSO on one channel whilst the other is left tuned to a calling or net frequency. That way you can keep an eye (or ear!) out for activity on the net or calling channel whilst continuing with a QSO elsewhere. Most SDR receivers with multiple channel receive capabilities will also have the facility to split or mix their receivers between the left and right audio channels. In an analogue scenario you may have separate

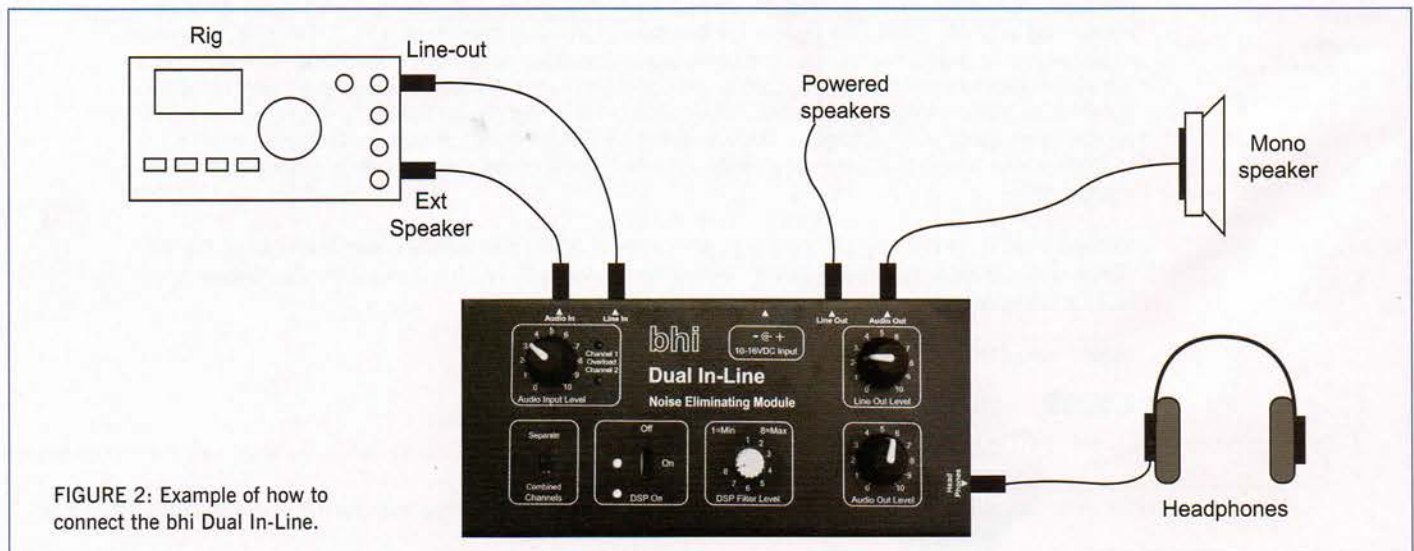


FIGURE 2: Example of how to connect the bhi Dual In-Line.



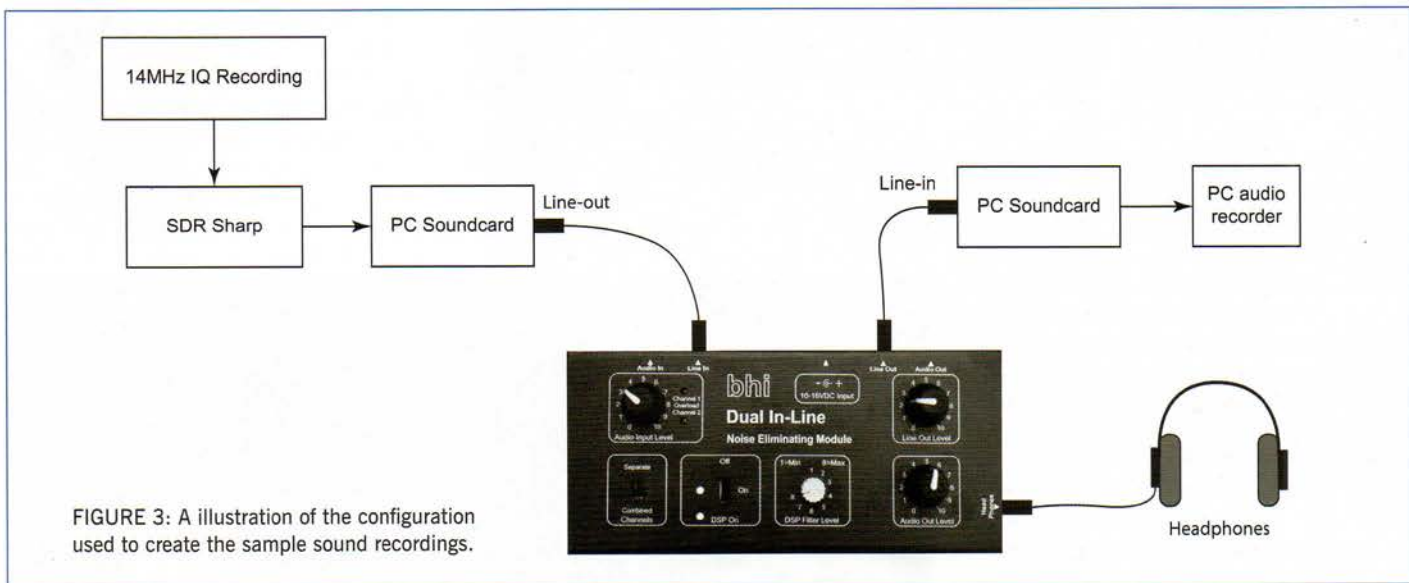


FIGURE 3: A illustration of the configuration used to create the sample sound recordings.



VHF/UHF and HF rigs in the shack. By making or buying a simple Y lead to split out the left and right channels you could connect both receivers to the line-in or audio-in jacks of the Dual In-Line.

Operation of the Dual In-Line has been made extremely simple. The first task, after making the connections, was to adjust the input level so that the peak indicators remained extinguished. The use of LED peak indicators worked very well and they were able to clearly show very short duration peaks. With the input level set I could use the two output level controls to adjust the line and speaker output levels independently. The provision of two independently controlled output jacks was very useful as the audio out could be used to feed headphones/speakers whilst the line-out could be passed to a recording device or external decoder. The headphone and speaker setup could prove very useful for club or special event stations as both can be used simultaneously. In many systems, use of the headphone jack disables the speaker but in the Dual In-Line they have separate amplifiers so you can run both simultaneously. In a club or special event station scenario the powerful speaker output could be used for general listening whilst the operator uses headphones.

Operation of the noise elimination system is very straightforward with an on/off switch and an 8-position rotary switch to set the degree of noise elimination. As with most noise reduction systems, I found it generally

best to use the lowest setting that provided sufficient noise reduction.

**PERFORMANCE.** For the performance testing I used the Dual In-Line throughout the HF and VHF bands. On VHF I used one channel to process the output of the Yaesu rig whilst the other channel was connected to my PC running *SDR-Console* software with a FUNcube Dongle Pro+. I was monitoring local repeater activity on the Yaesu whilst the FUNcube Dongle SDR was tuned to the S20 simplex calling frequency. By setting the Dual In-Line DSP to 6 I was able to leave the squelch open on S20 whilst listening to the local repeater. The Dual In-Line reduced the open channel hiss to a quiet watery sound. With this setup I would be sure to capture any activity on S20 without having to listen to white noise.

When used to reduce the noise on a wanted signal the new noise reduction algorithm worked extremely well. With most DSP noise reduction units a side effect of the process is a watery sound in the background. In the Dual In-Line this was very well controlled and was largely absent when using settings from 1-5, even when receiving very weak stations. Above 5 the watery artefacts tended to increase but only when listening to the very weakest stations. When monitoring medium to strong signals I was able to use the full range of settings. The degree of noise reduction provided by the Dual In-Line is excellent and even setting 1

provides a 9dB reduction in the noise floor. To help you appreciate the benefit of the Dual In-Line I have posted a few recordings on my website. The recordings were made using a FUNcube Pro+ dongle working with *SDR Sharp* as the SDR software on the PC. *SDR Sharp* was used to make an I/Q recording of part of the 14MHz band, which was subsequently replayed in a loop. I then made an audio recording from the line-out connector of the Dual In-Line with a variety of noise reduction settings applied using the Dual In-Line. I've shown a block diagram of the setup in Figure 3. The file names should be self-explanatory and are used to demonstrate the improvement offered by the Dual In-Line with an assortment of DSP settings. As you will hear, the Dual In-Line made a significant improvement even on the lowest settings. When dealing with very weak stations the DSP artefacts become more noticeable as you increase the DSP setting. However, when listening to reasonably strong signals the higher DSP settings were fine.

**SUMMARY.** The Dual In-Line is an excellent new noise elimination module that worked very successfully during the review. The noise reduction control was well defined and made it easy to adjust the trade-off between noise reduction and DSP artefacts for a wide range of signals. In addition to its noise reduction capabilities, the arrangement of level controls and dual channel operation make the Dual In-Line not only a useful addition to the shack a very attractive proposition for club, special event and contest stations.

The Dual In-Line costs £229 including VAT at 20% and is available directly from bhi via the online shop at [www.bhi-ltd.com](http://www.bhi-ltd.com) and the Dual In-Line is also available from several amateur radio suppliers. My thanks to bhi Ltd for the loan of the review model and for their technical support during the review.



bhi Dual In-Line top panel connections.