UPGRADING THE ICOM IC-705 WITH BHI'S AMAZING NOISE REDUCTION MODULE

An easily accessible, multi-function button on the IC-705's "back rim" gives a great improvement over the stock noise reduction. (ICOM, with all your resources, why can't you design a DSP NR circuit that works as well as BHI's?)

I admit it! I'm in love with **BHI Ltd.'s** DSP noise reduction accessories. I've owned most of their popular models like the DSP Desktop Speaker, and have installed BHI low-level audio modules in six different receivers and transceivers.

How is it that an audio-based DSP noise reduction accessory can be so effective? Only BHI knows, but they clearly have top-notch algorithms that rival the best of noise reduction circuits in contemporary Yaesu transceivers. (Personal bias alert: I find Yaesu's approach to noise reduction ("DNR" in Yaesu-speak) to be quite superior to ICOM's, and this is what got me thinking about improving the transceiver with an internal **BHI NEDSP1901-KBD** module in the first place.)

The noise reduction feature in the IC-705 and its IC-7300 base station counterpart is merely "OK" in my opinion, but the addition of BHI's NR makes a significant difference in S/N and intelligibility of signals. It's simple enough to use an external BHI product and connect it to your rig's speaker or headphone's audio path, but it adds wiring and complexity. The ICOM IC-705 modification described in this article is a neat, clean, internal solution needing no external wiring or power supply.

As a medium wave DXer of overseas, 9 kHz-spaced broadcasters from my West Coast USA location, I chase DX targets which fight to get past powerhouse domestic station splatter on adjacent 10 kHz channels. There's often the local QRM and RFI from neighborhood sources to contend with too. In fact, the struggle is not unlike a ham radio contester seeking to hear and work a DX station on a crowded, interference-plagued

band. What DXer–ham or broadcast–wouldn't love to improve the clarity and audibility of their transceiver or receiver? That's what this mod is about.

As with any construction project, this IC-705 modification is done totally at your own risk. Warranties will be voided, and your ICOM might become an expensive paperweight. SMD rework and careful soldering skills are essential to operate on the tightly packed, complex IC-705.

With that in mind, let's begin!

This mod uses BHI's newest low-level audio module, the **BHI NEDSP1901-KBD**. It replaces the earlier NEDSP1061-KBD and offers even greater noise and tone reduction (up to 40 dB, in eight selectable levels). At today's exchange rate the ex-VAT 99 GBP price of the module is **$139 USD** (plus shipping) direct from BHI Ltd. in the UK.

The basic idea is to interrupt the IC-705's audio path just upstream of the audio power amplifier (IC273, Main Board) and insert the BHI module, and power it from 5-15 volts inside the IC-705.

First things first– here are two important references you'll want to have on hand:

- **BHI NEDSP1901-KBD Installation and Operating manual**
- **ICOM IC-705 Service Manual** (you may need to register on the Mods.dk web site before downloading this large file)

The BHI manual above has clear block diagrams outlining the addition of the module into the low-level audio path.
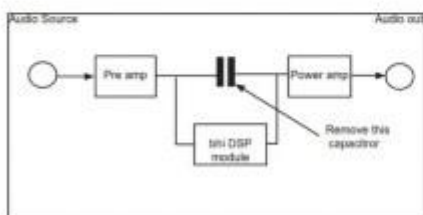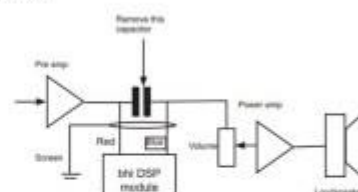

Figure 3. Basic connection diagram

Figure 4. NEDSP1901-KBD Audio path

For optimum performance provide the module with a constant amplitude signal, for example before the volume control.

Figure 5. NEDSP1901-KBD recommended position.

Note:
On some modern receivers/transceivers the volume control is digital and doesn't operate in the audio path. Contact the manufacturer for advise for the most suitable position for the DSP module.

The note on the lower right of the diagram mentioning a digital volume control applies to the IC-705.

Fitting it all in. The space between the IC-705's Display Board and the rest of the transceiver's stacked PCBs is the only logical spot to mount the 28mm X 37mm X 9mm noise reduction module. BHI provides a piece of double-sided foam tape for mounting. The position is slightly to the right of bottom-center (when looking at the Display Board from the back). It's important to avoid any interference with the flexible ribbon cables

between the Main and Display Boards, or other wiring, when the modified radio is closed back up.
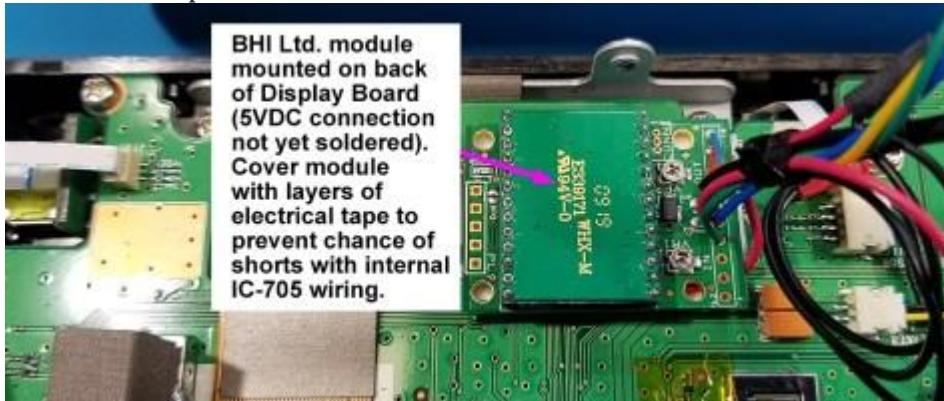

The NEDSP1901-KBD is a compact unit, which is very fortunate or this internal mod would never work in the packed confines of the IC-705.

It took three tries before I found a good DC connection point (5 volts or greater) that was free of conducted RFI. Small ferrite beads did not lessen the noise or hash, but one 5 volts DC point at the main tuning encoder jack J161 is completely free of this interference.
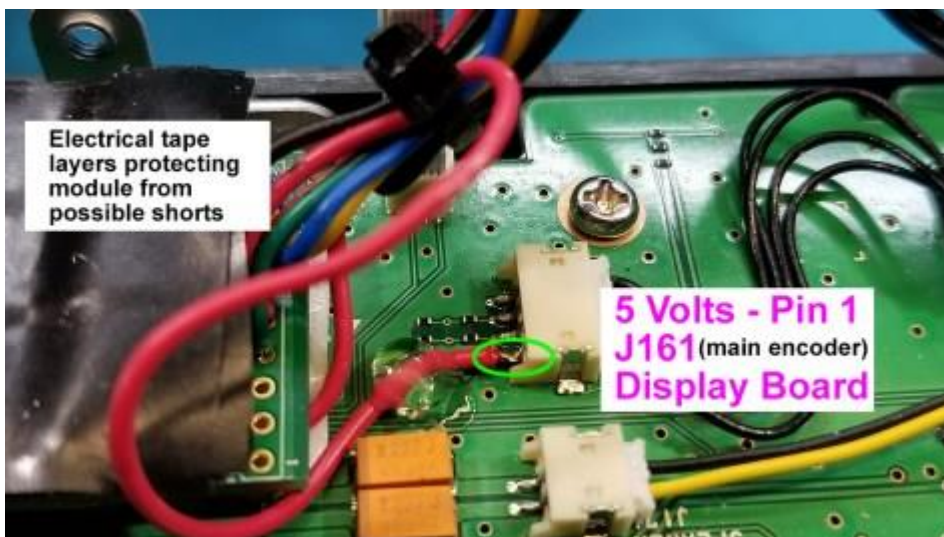
Pin 1 on main encoder jack J161 powers the noise reduction module free of any conducted RFI (a potential problem for wiring so close to the IC-705's digital wizardry). The exposed side of the module is full of sharp, pointy bits, so an insulation layer of electrical tape is a
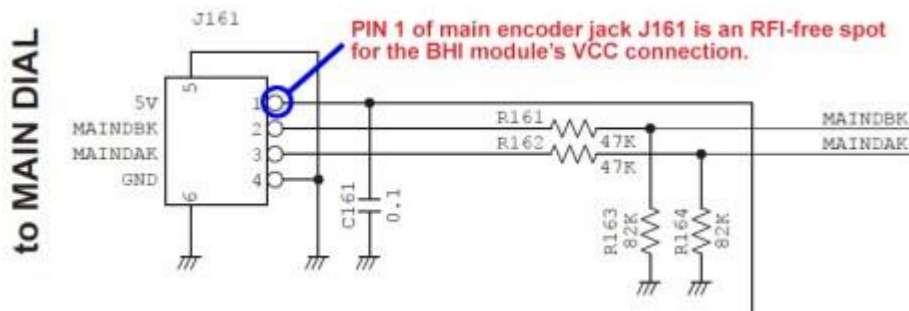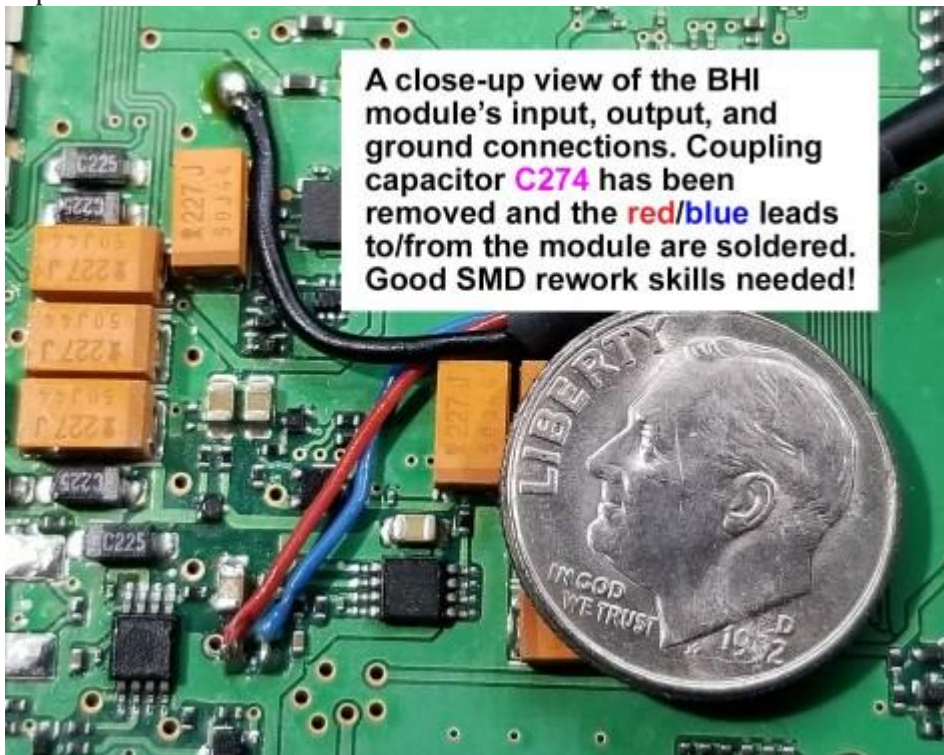

good idea.

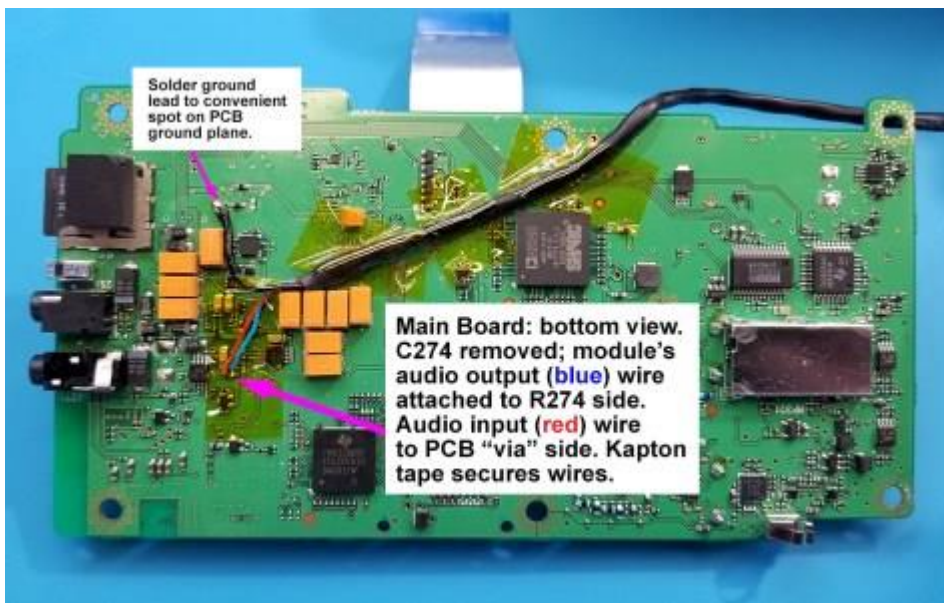Schematic view of J161, main encoder jack on the Display Board.

A shielded cable connects the module to the audio connection points (and ground). Typically a coupling capacitor is removed and the I/O leads are soldered to the pads at this spot on the circuit board. For the IC-705, the key component to remove is capacitor **C274** on the bottom of the Main Board.

A close-up view of the BHI module's input, output, and ground connections. Coupling capacitor C274 has been removed and the red/blue leads to/from the module are soldered. Good SMD rework skills needed!
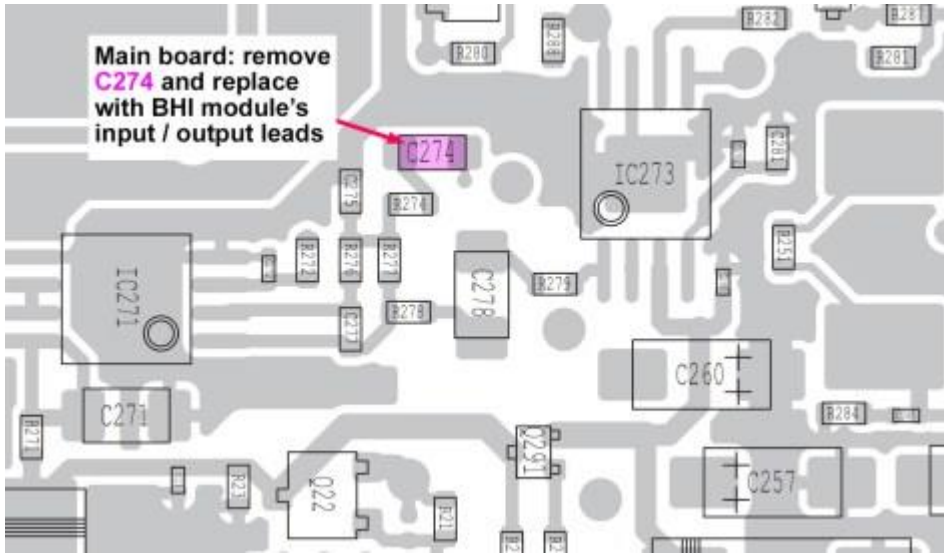
Red and blue wires mark the spot where C274 used to live. A connection to the ground plane can be made at any convenient nearby spot (just make certain the spot is indeed at ground potential and not a voltage trace).

Another view of the Main Board and added wiring. The black I/O cable snakes up from the board, past a metal shield, and to the module which is fastened to the Display Board.

Solder ground lead to convenient spot on PCB ground plane.

Main Board: bottom view. C274 removed; module's audio output (blue) wire attached to R274 side. Audio input (red) wire to PCB "via" side. Kapton tape secures wires.
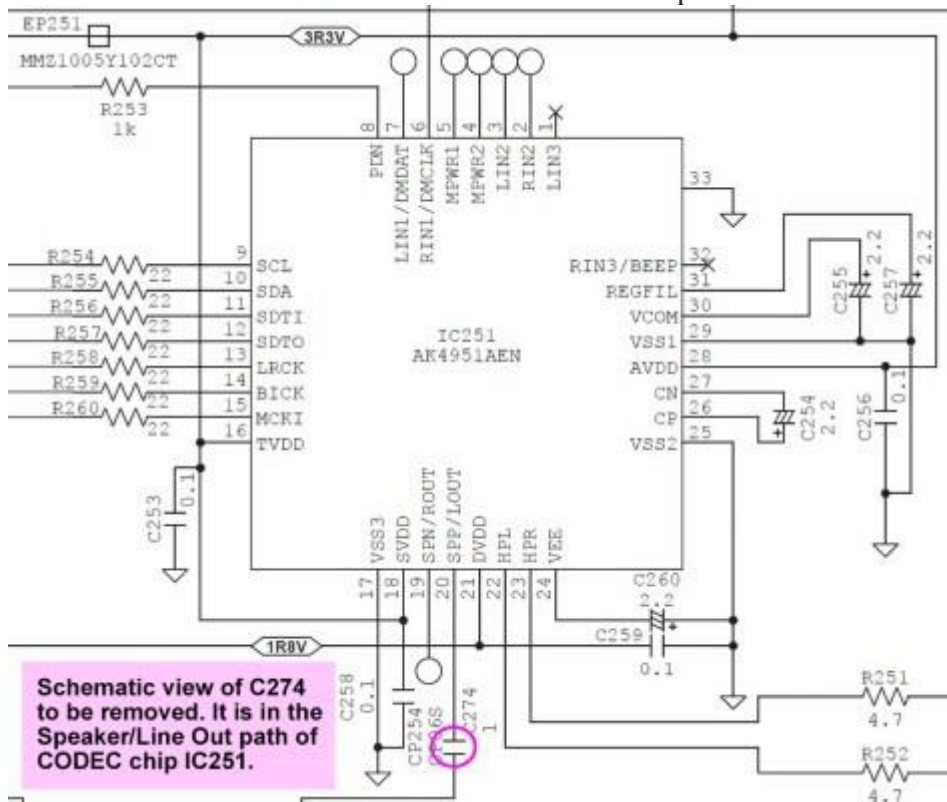
The entire Main Board (bottom view) is shown for reference.

A parts layout view shows C274's location relative to other components.

Schematic view of C274 to be removed. It is in the Speaker/Line Out path of CODEC chip IC251.

What's special about C274? It's in a direct path from the AK4951AEN CODEC chip (IC251), the mono audio output of the IC-705.

Steady as she goes! The preparation of the IC-705's enclosure to mount the switch/LED board takes a steady hand and (in my case anyway) nerves of steel. It's necessary to grind away at least 50% of the thickness of the radio's case where the small PCB mounts so the button on the switch/LED board protrudes far enough for operation. I ran into the same "too thick" case problem when fitting a BHI NR module to an AOR AR7030 Plus receiver.

I used a Dremel rotary tool with a tapered grinding wheel to whittle away some of the ICOM's dense plastic. Lot's of trial-and-error fitting ensued, along with sighs of relief when the job was done and the switch/LED board was in a perfect position. Proceed slowly and don't remove too much material at once.

Before this crucial step though, it's best to try out the noise reduction module to make sure it works correctly. You'll also want to adjust the two potentiometers on the module as described on page 14 of the manual.

You can reduce (but not eliminate) the module's beep level with solder links (bridges) at B1 and B2. I find the lowest volume still a bit too loud. I asked BHI about this and was told: "*On the back of the module there are 3 resistors R6, R7 and R8. I think changing R6 to a 100k would get us closer to the mark, you then have the bridges to give you some further reduction. If that's a bit too stiff, R6 could be set to 47k which give you 3dB more Beep.*" I have not tried these suggestions yet.

The initial step of drilling exact diameter holes for the button and LED needs careful measurement. See page 25 of the BHI manual detailing the 3.5mm and 4.0mm holes, spaced 5.1mm center-to-center. A digital calipers helps for this step. When done correctly the holes align with the pre-cut, self-adhesive label.

The controlling switch/LED is mounted on the right-rear edge of the "rim" of the IC-705, a spot I settled on after other possible locations were investigated and eliminated for various reasons. The IC-705 is so tightly packed there is very little space available. I considered the top-front edge for mounting, but didn't want such a visible spot to be an eyesore in case I screwed up the drilling/carving step of the installation.

BHI switch/LED board mounting, rear view, interior of IC-705 enclosure.
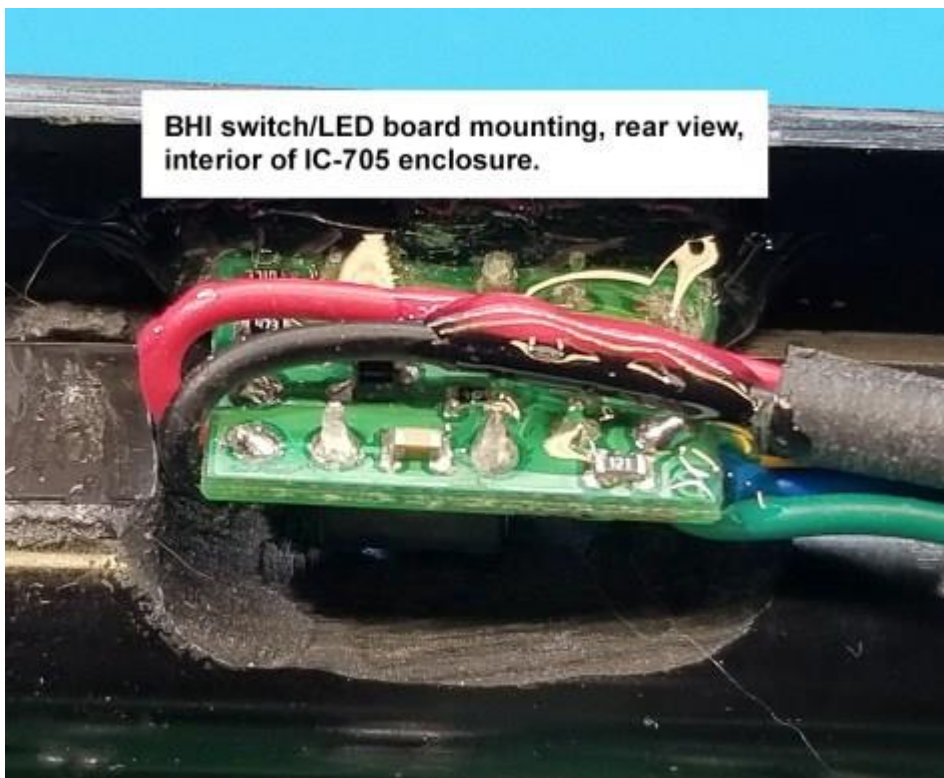
Carving and grinding the ICOM's enclosure to mount the tiny switch/LED board of the noise reduction module is guaranteed to raise your heart rate. It's hard to see in the photo, but the board is secured to the IC-705 case with clear, UV-setting adhesive.

The *Bondic* adhesive used to hold the board in place is an **interesting product** I found on Amazon last year. This adhesive remains in a slightly tacky, liquid state until hit with a few seconds of ultra-violet light. The kit includes a small UV penlight of the correct

color temperature to solidify the adhesive. For many projects this product is easier to use than two-part epoxy and holds nearly as well. Refill packs of the adhesive are also available on Amazon. I highly recommend this product for the occasional repairs around the house.

Another view of the switch/LED board location. Access to ports located beneath the rubber covers is still possible.

When installed correctly the switch/LED board is positioned as shown.

Final steps and thoughts

When you reassemble the IC-705, be very careful not to pinch or kink any wires of either the radio or the BHI module. Also take extra care with the two flexible ribbon cables between the Display and Main Boards, which inevitably you'll have to remove and reconnect a few times while making this modification.

ICOM's **IC-705 Service Manual** is one of the best I've seen in a long time. Take advantage of its wealth of information if you run into any puzzles about the mechanical or electrical intricacies of the transceiver.

Despite the module's control button mounted on the back rim behind the radio's front panel, it's easy to access. The number of beeps indicate the noise reduction level so it's not necessary to see the flashing LED. Even with a protective cage like the popular **Windcamp** and **Peovi** products, this button location is still easy to reach.

With this mod you can enjoy the BHI noise reduction through the internal speaker as well as with headphones. However, for headphones you need to use a mono adapter for stereo headsets, or connect an old-school monaural headphone. You'll need to set menu item CONNECTORS > SP JACK FUNCTION to SPEAKER and adjust the "Phones Level" setting if needed (I use the default "0" setting).

The reason SPEAKER is chosen is because the BHI NR modification affects the audio path for the speaker. The default audio path for headphones is different out of the CODEC chip and additional connections to the Main Board would be needed to use this (see pins 22 & 23 of the AK4951AEN CODEC chip).

Setting the SP JACK FUNCTION to SPEAKER lets you use still use headphones if desired, as long as they are mono, or stereo with a monaural adapter. This is a work-around approach which functions well.

The BHI NR is not available through the IC-705's Bluetooth audio. The audio is digital throughout the transceiver when BT is active and is transmitted digitally from the radio to the wireless device. The signal is not routed through the analog I/O leads of the BHI module.

Operation

The BHI manual describes use of the noise reduction module in detail, but basically it's dead simple to use. A quick push of the button engages or disengages the noise reduction, and overall volume is controlled with the radio's AF gain knob as usual. Longer presses on the module's small button cycle through all eight of the levels (each level getting more "aggressive"). Higher levels of NR can remove more noise, but at the expense of some audio quality and potential "watery" DSP sounds. However, I find the noise reduction artifacts of BHI to be less annoying than the stock IC-705 noise reduction.

The net result–to my ears–is more effective, more legible audio compared to ICOM's NR. Stronger AM and SSB signals become virtually "full quieting" with levels 1 – 3. In practice I rarely use a setting higher than 4, but all eight levels are available if needed. I have not tried the BHI noise reduction with CW signals but I understand it's considered very effective.

Comparison

The short video below gives a demonstration of the BHI noise reduction on broadcast and SSB amateur band signals, with a few moments of the 705's stock ICOM noise reduction, too (I've remapped this ICOM function to the VOX button).

You'll find **no** benefit to using both noise reduction features at once…don't even go there!

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