Sv3ora Antenna Noise Blanker (NR-1)

Quick reference manual

Version 8.0

What is the NR-1

The NR-1 is an RF interference removal device (Noise Blanker type), which allows the removal of impulse-type noise in the HF radio spectrum.

The frequency range, in which the NR-1 has been tested to operate, is from 1.6MHz to over 70MHz (modification for lowfer is possible). It is wideband and it can be used inside and outside the radio amateur bands (e.g. for listening to commercial shortwave stations too). No additional noise antenna is required for its operation.

What kind of noise does the NR-1 remove

NR-1 is a type of Noise Blanker and therefore it only removes impulse-type noise. This noise usually takes the form of pulses or "spikes" of short duration and high amplitude. Its repetition rate can vary from a few Hz to a few KHz. In the waterfall, this noise may appear like repeating horizontal lines that cover most (if not all) of the band. Such noise may be caused by sparking in devices such as:

- Faulty mains transformers and insulators
- Motors (elevators, household electrical appliances, etc.)
- Internal combustion engines (cars, motorbikes, generators, etc.)
- Inverters and switching power supplies (solar panels, chargers, LED lamps, routers, etc.)
- Any other device (defective or not) that cause, or will cause in the future, such impulse-type noise

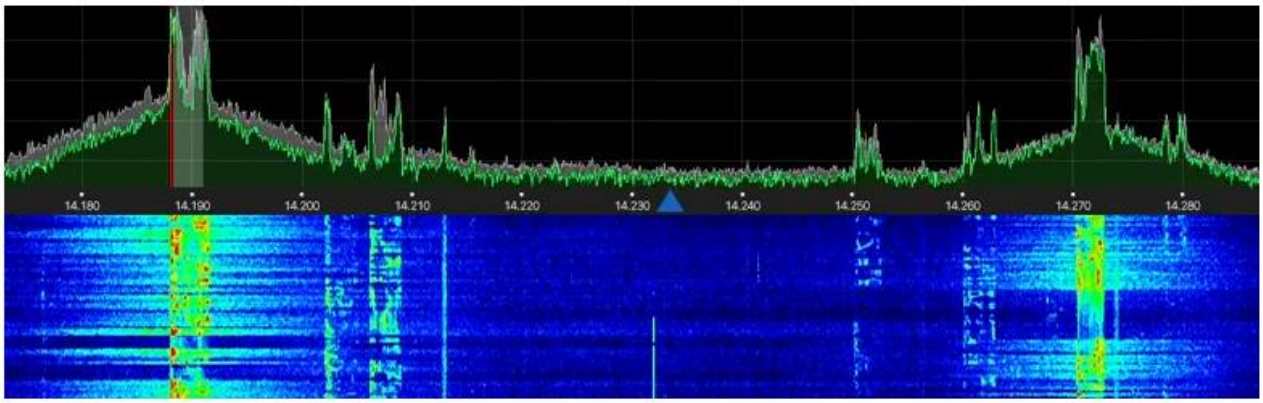
The NR-1 is exceptionally effective on power-line noise, whereas other noise removal devices struggle.

Comparison of the NR-1 with common (internal) noise blankers of radios

The NR-1 works directly on the antenna side and not in the intermediate frequency that common radios/receivers noise blankers work on. Furthermore, the principle of operation of the NR-1 is not based on cutting-off of amplifiers, unlike common noise blankers do. Because of these, the NR-1 has a number of important advantages, compared to common internal Noise blankers of radios, which are summarized as follows:

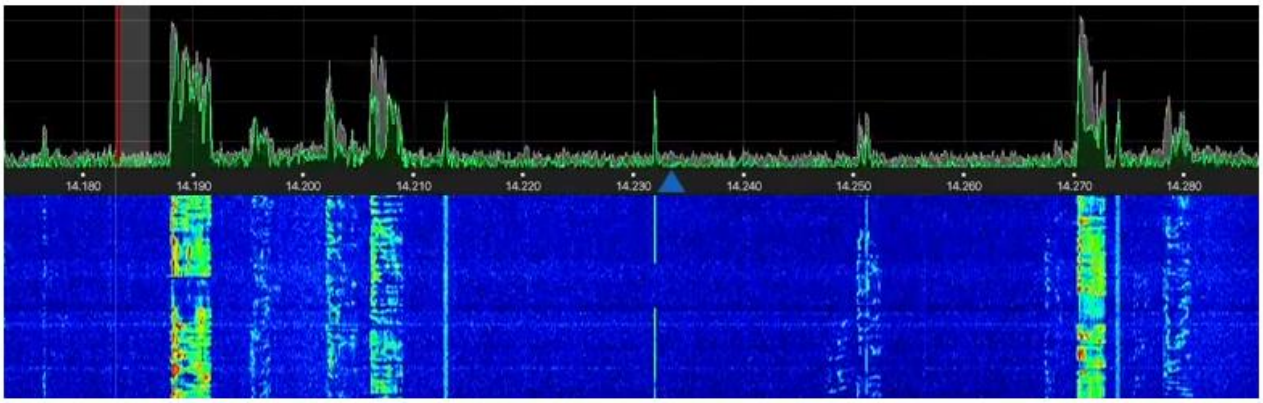
- **NR-1 removes noise before it even reaches the receiver.** Because of this, the front-end RF stages of the receiver are unaffected by noise. This improves the receiver dynamic range, as the AGC is unaffected by noise. In contrast, a common internal noise blanker, removes the noise after it has first passed through the internal circuits of the receiver.

- **NR-1 completely cleans out the waterfall display of modern transceivers**. In contrast, common internal noise blankers (eg. IC-7300) leave the noise displayed on the waterfall, when they manage to clean the audio (IF).
- **NR-1 removes high-level, high-repetition-rate noises** that common internal noise blankers usually cannot cope with.
- **NR-1 is not affected by strong near-by signals.** Instead, common internal noise blankers perform poorly when there are strong near-by signals and they distort the signal quality of the station we want to hear. This distortion caused by the common noise blankers, is the reason most HAMs prefer to listen with the noise blanker switched off.



Internal noise blankers of radios (above): **Distortion on strong signals.**

NR-1 noise blanker (below): **No distortion on strong signals!**



- **NR-1 can be used by many radios at the same time.** Because it is an external device, it can be connected to various radios/receivers without the need to modify them.
- **NR-1 has a built-in 8-band preselector** and helps eliminate intermodulation (birdies) caused by strong local medium and shortwave stations, on RF direct sampling radios (eg IC-7300). The preselector is relatively wideband and does not affect the sensitivity or the waterfall spectrum in the amateur radio bands, even at big spans.

- **NR-1 has built-in variable gain preamplifier and variable attenuator.** Preamplification is particularly useful in the high frequency bands, where some radios have limited sensitivity. Variable attenuation helps to reduce band noise for more comfortable listening to mid/high strength stations.

Comparison of the NR-1 with other noise removal systems

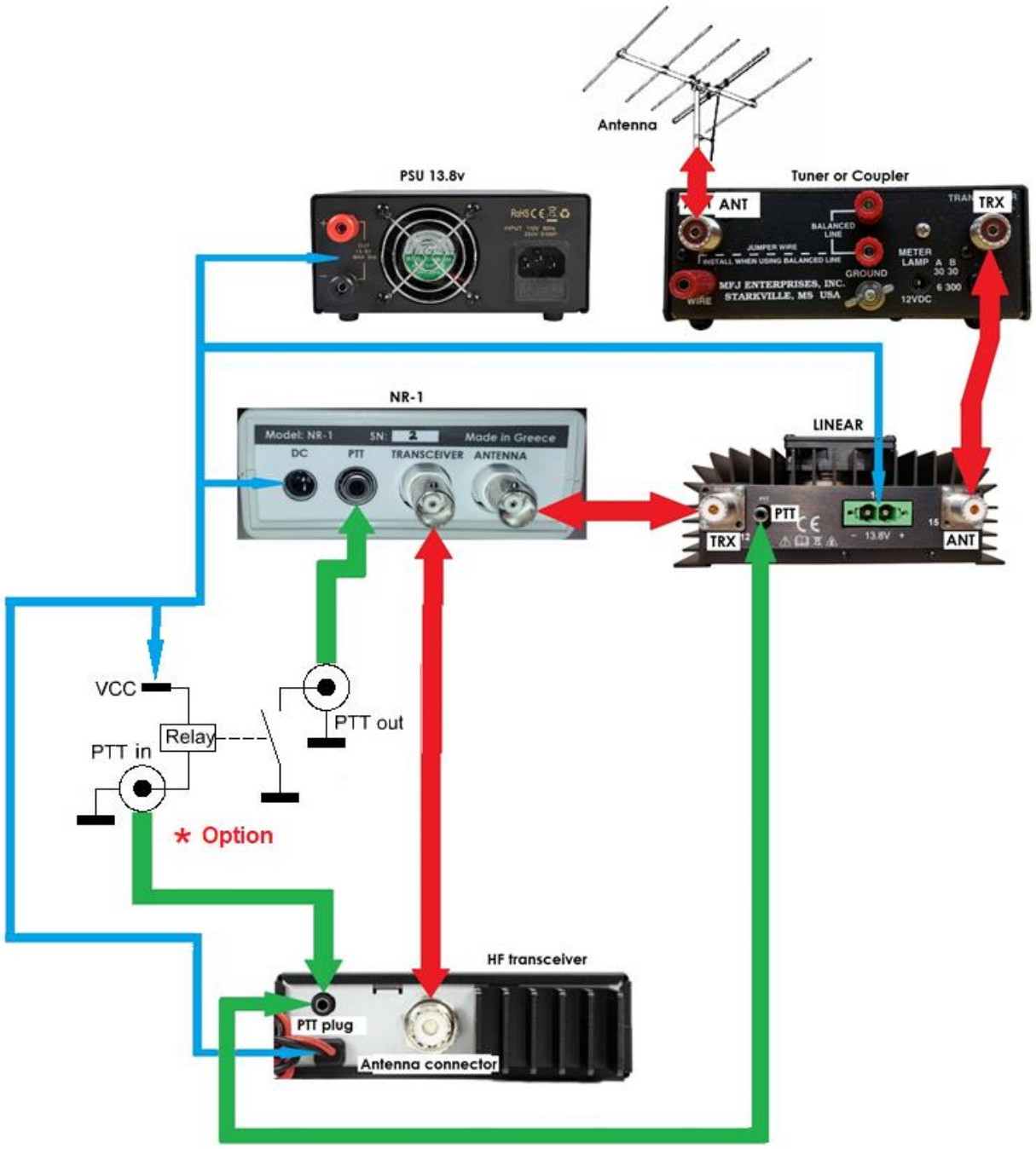
The types of noise encountered in shortwave are many and varied. Therefore the NR-1 does not make obsolete the other noise removal technologies, such as the QRM eliminator/X-phaser and the NB/DSP of the radios. Its purpose is to work either independently or in cooperation with them to achieve the best possible result, depending on the type of noise. Nevertheless, the NR-1 has significant advantages over devices such as the QRM eliminator/X-phaser, which can be summarized as follows:

- **NR-1 does not require a second (noise-sense) antenna/coaxial-line to operate.** Unlike QRM eliminators, NR-1 does not require an additional "noise-sense" antenna and therefore no second coaxial cable out of the shack. The main transmit and receive antenna already in use, is sufficient.
- **NR-1 is easy to set up.** In contrast, QRM eliminators require systematic testing of various noise antennas in different locations to perform satisfactorily.
- **NR-1 removes noise from every direction simultaneously.** In contrast, QRM eliminators, depending on the noise antenna setup and their configuration, remove noise from one direction only each time. If the noise originates or "travels" through cables and reaches the antenna from different directions, QRM eliminators do not perform well. The NR-1 does care about the direction of the noise and therefore it is exceptionally effective on power-line noise.
- **NR-1 removes more than one noise sources simultaneously** because its principle of operation is not related to the phase of the noise.
- **NR-1 does not require constant adjustment.** Once set for one band, it usually does not need to be reset. In contrast, QRM eliminators require resetting every few tens of KHz or so.

How to connect the NR-1

The NR-1 is connected between the transceiver (or receiver) and the antenna. If there is a Linear in between, the NR-1 is connected between the transceiver and the Linear. Under no circumstances should one connect the NR-1 between the Linear and the antenna because it may be damaged. The NR-1 has been successfully tested with radios that have a maximum RF output power of 200W in SSB mode. However, as far as propagation allows, it is recommended to use the lowest power possible. Additionally, when tuning with tuners/couplers it is a good practice to use as little power as possible during tuning to avoid stressing the NR-1 and your transceiver.

The following picture shows an example of the wiring of a typical radio amateur station. The blue lines are the power supply to the various devices. The red lines are the radio signals (coaxial cable). The green lines are the PTT control signals. An example of an OPTIONAL PTT relay isolator is shown, but please read the warnings!



*** Option**
Optional external PTT isolation
(useful when there is "RF in the shack" or not true PTT ground present)
(warning! with this option, VCC present on PTT on key up)

The power supply is connected to the DC input of the NR-1. NR-1 requires a stabilized 13.8v supply. It is risky to connect 12v (internal relay may not switch) or more than 14v. The current it consumes is negligible and the

power supply of the transceiver can be used if it is 13.8v regulated. The inner conductor of the DC plug is the positive pole and the outer conductor is the ground. Although there is a reverse polarity protection, it is recommended to confirm the connections before connecting the power plug to the NR-1. If, for any reason, the power to the NR-1 is cut off, the NR-1 is automatically bypassed.

The PTT line of the radio is normally connected to the PTT input of the NR-1 (unless you use an isolation option in line)**.** This line is also connected to the corresponding input of Linear for its control (activation/bypass), if a Linear is present. The inner lead of the PTT (RCA) plug is the control lead and the outer lead is the ground. NR-1 goes into transmit mode (bypassing the NR-1) when the PTT's internal control lead (RCA) is connected to ground or when the ON/OFF switch is in the OFF position. NR-1 goes into receive mode (NR-1 enabled) when the PTT's internal control lead (RCA) is left open (from SN: 28 and above, a small positive voltage can be tolerated too).

Before connecting the NR-1 to the transceiver, one has to make sure that a good quality (shielded) RCA cable (with split-core ferrite chokes attached to it ideally) is properly connected to the transceiver and that the inner conductor of the cable is shorted to the outer (ground) when the transceiver is transmitting. Otherwise the NR-1 may be damaged if one tries to transmit while the NR-1 is in receive (powered) state. Then the cable must be connected to the PTT jack of the NR-1 and one has to confirm that the relay inside the NR-1 makes a characteristic “click” sound when the transceiver is switched to transmit. On 12v operation (not recommended) make sure that the relay can switch reliably too. Make sure that the RCA connector of the cable, has been completely inserted to the RCA of the NR-1 and it makes a good contact. The above steps are recommended to be performed before connecting the radio coaxial cables to the NR-1 (this is VERY important).

One point to be particularly aware of, is the delay of the PTT line of the transceiver, which is activated when it transitions from receiving to transmitting. Some transceivers have associated delay settings and it is recommended to be set up, so that the PTT line is activated slightly before the transceiver transmits. This setting provides protection to the transceiver, but also to all external devices controlled by the PTT, such as the Linear and the NR-1.

Other **very important** points to be particularly aware of, is the presence of “RF” in the PTT line, DC offset, ground loops, or not a true PTT to ground connection. “RF” in the PTT line might be caused by improper matching of the transceiver to the antenna, common mode currents in the antenna coaxial or in the shack, etc and it is more evident in high transmit power. Ground loops can be caused by long improperly grounded PTT cables. Non-true-ground PTT connections can be caused by internal circuits of the transceivers. All of those things must be checked, or else they might cause unwanted relay switching and eventually damage the NR-1. I have made this youtube video as an example of the problems I faced. I have also made another youtube video which shows how I got away with those problems without using an isolation relay (although recommended). I simply changed the 10K resistor that is closest to the PTT RCA, to a 220K one. SN: 140 and above, do not need this modification.

If one has a transceiver that uses other PTT connectivity (the NR-1 requires a true ground on TX), the appropriate action must be taken, to make the systems compatible. Usually this is done by connecting external circuits to the PTT line. See an option in the schematic in the picture above, of an example for a PTT isolation circuit (and read its warnings!). Technically, the center lead of the RCA plug on the NR-1 is connected internally to the base of a PNP bipolar transistor (through a current limiting resistor on SN: 28 and above), which is grounded when the transceiver is in transmit state. Attention needs to be paid to the total transition delay of the PTT, mentioned in the previous paragraph. Transmitting, even slightly, while the NR-1 is in receive mode may damage the NR-1

and/or cause transceiver problems. The things mentioned above, are so important to follow for protection of the NR-1, thus I am giving you a list of steps to check below.

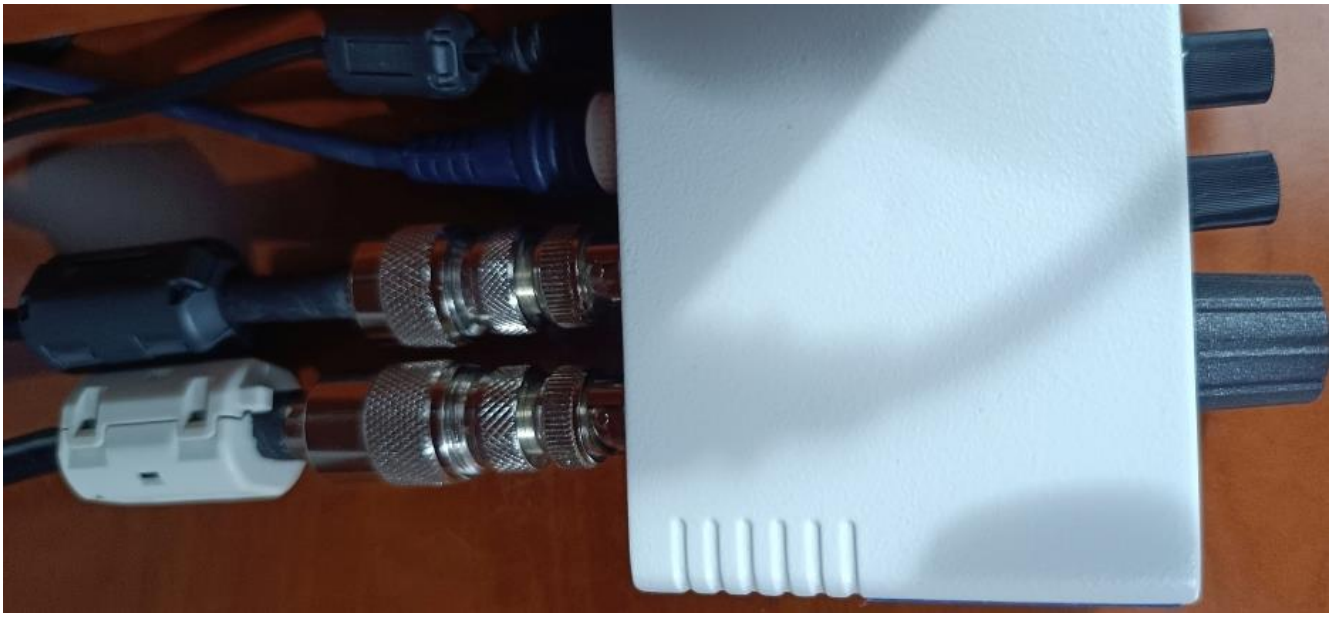
Proper connection procedure steps for the PTT:

(DO NOT MISS ANY OF THOSE STEPS or you risk damaging the NR-1!)

1. Unpack the NR-1 and connect the proper DC power, ensuring a good firm plug connection.
2. Connect a shielded ferrite-choked RCA cable to the PTT of the NR-1, ensuring a good firm plug connection. Do not connect any RF cables to the NR-1 yet!
3. Tune your transceiver correctly for minimum SWR.
4. Switch ON the NR-1.
5. Set your transceiver power to minimum.
6. Transmit for no more than 1 second, by whistling on SSB or by carrier on FM/CW.
7. You should hear 1 click of the relay on PTT (TX) and 1 click when you release the PTT (RX). If you hear more than those number of clicks, or relay buzzing (usually along with high SWR), or no clicks at all (again high SWR), then **stop immediately** and make actions to isolate your PTT line! If everything goes well, continue to step 8.
8. Gradually, in steps, increase the output power of your transceiver (and your linear if you use one). For each output power level, follow closely the procedure in steps 6 and 7. If everything goes well up to full power, proceed to step 9.
9. Now, connect the RF cables to the NR-1.
10. With the RF cables connected, repeat steps 5 to 8 above. DO NOT MISS ANY STEP or you risk damaging the NR-1!

If one uses the NR-1 only for listening with a receiver and not for transmitting, he does not need to connect the PTT connector, because the NR-1 remains in receive mode after it is turned on (ON/OFF switch to ON).

The transceiver antenna connector, is connected to the "TRANSCEIVER" connector of the NR-1. A piece of coaxial cable must be used to connect and convert the BNC of the NR-1 to PL-259/UHF if the transceiver uses one. Instead of converting cables, you can also use SO-239 to BNC male adaptors, as they fit just about right. However, if using adaptors take care that you do not mechanically stress the BNC ports of the NR-1 and make sure the adaptors are not loose and make good mechanical contact as you move the NR-1 around. Below, there is a picture that shows the use of adaptors for connecting the NR-1. In this case split-core ferrites have been used at the RF and DC ports. It is recommended to use one also in the PTT line port.



On QRP radios that have a BNC plug, you need a BNC to BNC cable. If one has more than one transceivers or receivers connected with an RF switch to a single antenna, then the TRANSCEIVER jack of the NR-1 must be connected to the common output (antenna) of the RF switch. Do not use more force than needed when connecting and disconnecting the BNC cables, to avoid damaging the pads of the connectors.

The antenna is connected to the "ANTENNA" connector of the NR-1. If there is a Linear, wattmeter/swrmeter, tuner/coupler, multiple-antenna RF switch or other devices, they should be connected to this jack. If one has other noise-removal systems connected to the transceiver, such as a QRM eliminator or X-Phaser, he can experiment with their connection. For example connect the NR-1 directly to the transceiver and then the QRM eliminator in series to it. Or vice versa, connect directly the QRM eliminator to the transceiver and then the NR-1 in series to it. Do not use more force than needed when connecting and disconnecting the BNC cables, to avoid damaging the pads of the connectors.

Tuning of the NR-1

Like all noise-removal systems that act directly on the antenna signal, the NR-1 requires tuning too to eliminate the noise. The NR-1 is adjusted using the knobs on the front panel. Knob settings interact with each other to achieve the desired result. Ideally, one would want the useful signal and the background noise levels of the band to remain the same like when the NR-1 is turned off, but with the interfering impulse noise to be eliminated or attenuated. There are of course different ways in which a signal can be made intelligible, for example some people prefer to receive with the attenuator on. Therefore, the tuning of the NR-1 can be done in different ways, depending on the desired result. There are 5 buttons/knobs on the front panel of the NR-1 and their function and settings are explained below:

The ON/OFF button turns the NR-1 on or off. It is useful for instantly comparing the reception with the NR-1 on or off, without the need to plug and unplug cables. With this comparison, one can find out how satisfactorily he

has removed the noise or not. If the NR-1 is bypassed (knob in the OFF position) the power to the NR-1 is automatically switched off.

The OUTPUT knob sets the attenuation of the NR-1 output. As long as all the other knobs are adjusted sufficiently and the impulse noise is eliminated, one can use the OUTPUT to lower the overall band background noise (and the level of the preamplified signals). The output should be ideally set in such a level, that the background band noise and the useful signals, remain at the same level like before the impulse noise removal procedure. Too much output will flood the waterfall with amplified signals and background noise (and in extreme setting will cause IMD). Too low output and those signals are attenuated.

The IMD knob reduces the intermodulation of the NR-1, caused by strong stations (MW or otherwise "out of band") when the NR-1 is set to high gain mode. It also helps to eliminate "birdies" caused by strong medium and short wave stations in RF direct sampling radios (eg IC-7300). This is an 8 position preselector. The preselector is relatively wideband and does not affect the sensitivity or the waterfall spectrum in the amateur radio bands, even on big spans.

As one turns the IMD to the left, he selects lower and lower frequencies. As one turns the IMD further to the right, he selects higher and higher frequencies. From SN: 28 and above, the 1st position is better suited to 160m, the 2nd to 80m, the 3rd to 40m, the 4th to 30m, the 5th to 20m, the 6th to 17/15m, the 7th to 12m and the 8th to 10m and above. However, it is not necessary that if one is operating on 160 meters for example, he should turn the IMD all the way to the left. Depending on the rest of the NR-1's settings, he may find that he gets better performance with the IMD in other nearby settings. If one cannot achieve the desired result with the GAIN and BALANCE adjustments (interference suppression and sufficient signal levels without intermodulation), the IMD usually needs to be readjusted. The purpose of the IMD is to prevent intermodulation from strong stations and not to act as a classic narrowband preselector. This is why it is designated as IMD and not as a preselector with distinct frequency ranges on the front panel.

The GAIN knob sets the gain of the NR-1. The GAIN setting is important for noise cancellation, as it essentially selects the signal threshold level that the NR-1 will consider as useful or interfering. The NR-1 has a very high gain wide bandwidth built-in amplifier. It is wrong for GAIN to be set to maximum (far right). All that will be heard is noise and hiss (IMD), much louder than the interference one is trying to suppress.

Depending on the setting of IMD and BALANCE, the GAIN should ideally be set at such a level that the interference stops, without causing additional background reception noise. At the same time, the useful signals should not be attenuated significantly. Obviously, this is the final desired result, and there is an interaction of all the knobs on the front panel of the NR-1, not just GAIN. For example, in some cases (especially in higher bands) the GAIN should be increased clockwise, while in others (lower bands) it should be almost all the way to the left. Controls are "touchy" in some cases, so proceed in small steps until you familiarize yourself with the adjustment.

To help in the adjustment of the GAIN, one can start by setting it close to the minimum (far left). As he increases the GAIN clockwise, there is a point where he will notice the band hiss to rise sharply and instantaneously to high levels. At this point, turn the GAIN slightly counter-clockwise until this hiss stops. This is usually an adequate GAIN setting and this will cut out lower noise levels. If one notices intermodulation distortion at this point (high band hiss or "ghost"/birdies stations), he can set the GAIN a little more counter-clockwise or change the IMD and BALANCE settings and try the GAIN setting again. If any of the IMD and BALANCE settings are changed, GAIN usually needs to be readjusted.

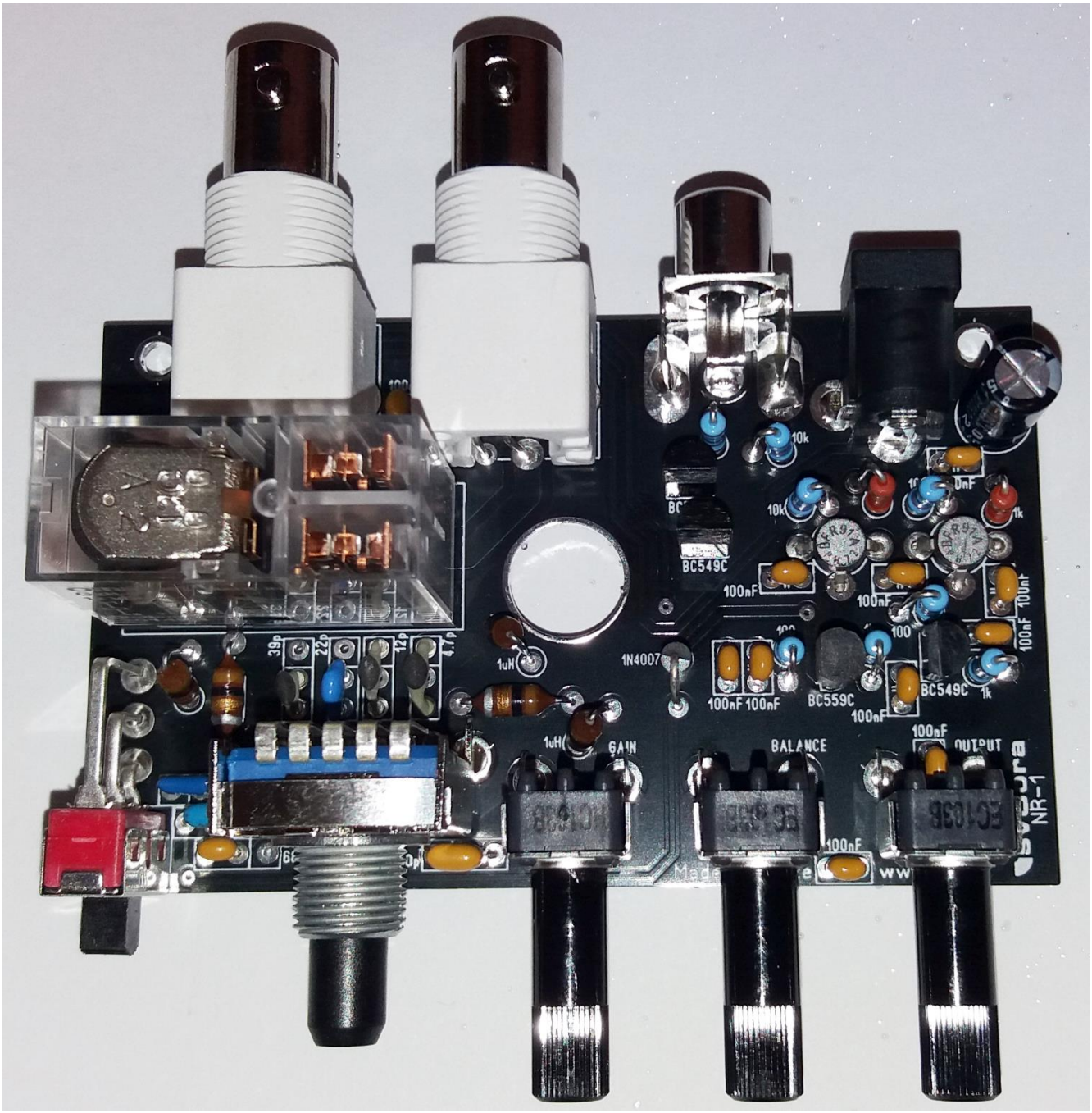
The BALANCE knob sets the balance between noise and useful signal on the NR-1. If one turns the BALANCE all the way to the left, he will hear the interfering noise amplified. If one turns the BALANCE all the way to the right, he will hear the desired signal along with the interference amplified. In this later position, one will most likely also notice intermodulation (high band noise). He must turn the BALANCE a bit counterclockwise until the background hiss noise returns to roughly the same levels as with the NR-1 off. If this is not possible without attenuating the signal too much, the OUTPUT knob can be used to set the band background noise level to more appropriate levels (but don't overdo it to avoid useful signal attenuation). If, with this new setting, the noise returns or the useful signal is greatly attenuated, one has to modify the GAIN slightly, without causing intermodulation. If he cannot achieve the desired result again, he has to rotate the IMD and try adjusting the BALANCE and GAIN again. If any of the IMD and GAIN settings are changed, the BALANCE usually needs to be re-adjusted. From SN: 28 and up, the BALANCE control is "relaxed" and it will probably need to be near 80-90% clockwise at all times, which makes tuning of the NR-1 easier.

Interesting facts about the NR-1

The components used in the NR-1 are of very good quality and most of them are from known brands. The following components and their associated companies are listed as examples:

- ALPS potentiometers
- Philips, Samsung, Vishay semiconductors
- Substantial Omron relay
- Vishay Resistors
- Philips, Murata, Vishay, Kyocera and Nichicon capacitors
- TDK (EPCOS) inductors
- Aluminum panels (SN:28 and above)
- All metal body RF connectors (SN:56 and above, not shown in the picture below)

The NR-1 has been designed to be small and lightweight in order to be easily carried in outdoor radio amateur activities (SOTA, POTA, IOTA, JOTA etc.). Thus, the RF connectors are BNC, the knobs on the front panel are slightly crimped and the box is small, light and ABS.



The PCB is factory-etched and designed to RF specifications. Because the circuit is turned off during transmission, it is not greatly affected by the lack of shielding from the ABS enclosure (but make absolutely sure there is no RF present in the PTT line though, and follow closely the PTT connection steps in the paragraphs above). The aluminum face plates (SN: 28 and above) are coated with silkscreen paint and the whole structure is held tightly and correctly aligned with a single screw. For this reason, it is recommended not to open the NR-1. Here is a photo to show what is inside it and how the NR-1 is internally assembled. In this photo, the plastic RF connectors version is shown (SN:56 and below).

The NR-1 is entirely an idea and implementation of Kostas sv3ora. It is "Hand-Made in Greece". It was an effort that started in 2020 in order to deal with the high noise levels in short waves. The antenna was located very

close to mains voltage transmission lines and as a result the interference traveled through these lines, ending up in the receiver from many directions. Every now and then, the mains power company (which thankfully responded in time) was employed to repair the problems at their transformer stations. Problems that, due to their nature, had to be identified after lots of effort and time. I decided to do something about it and not having to go through this process every now and then.

The effort and the endless time of experimentation and testing, finally paid off. Since then, the NR-1 has been used regularly in the shack whenever this noise appears and I no longer have to go through the above procedure. It has served me well and reliably over the years. It is still under development and improvements will be gradually made upon the requests of HAMs.

Eventually, I also started a YouTube channel, in order to show the effectiveness and the operation of the NR-1.

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DE sv3ora