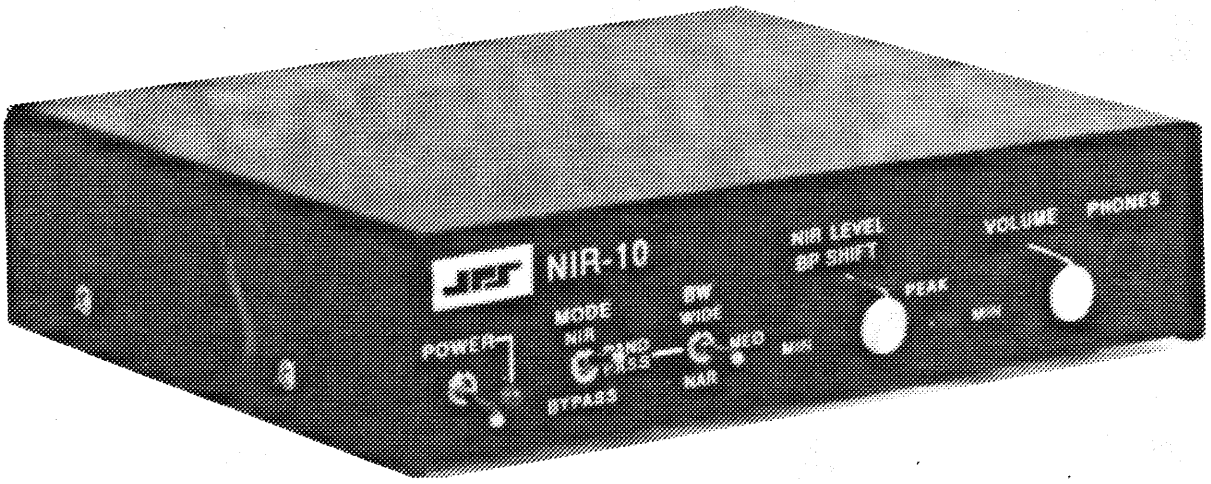
THE DIGITAL JPS NIR-10 NOISE AND INTERFERENCE REDUCTION UNIT

Guy Atkins



When significant advances in electronics technology occur, a predictable progression takes place. The military is among the first to get equipment incorporating the new technique, process, or hardware. Next in line is industry and finally the new development becomes available to the consumer market, often finding its way into a wide variety of products.

Such is the case with Digital Signal Processing (DSP). After years of refinement, the benefits of DSP reached the consumer in the mid-1980s with the release of the compact disc (CD) player. As the technology progresses, other products using DSP are being introduced.

The NIR-10, a Noise and Interference Reduction unit from JPS Communications of Raleigh, North Carolina, is a new receiver accessory that is the first to offer the benefits of DSP to the DXer. It effectively reduces broadband noise, repetitive impulse noise and other interference encountered while monitoring AM, SSB, CW, packet, and RTTY modes. In addition, a recent upgrade to the NIR-10's software provides automatic, multiple hetrodyne removal.

The NIR-10 is JPS Communication's first product for the ham radio/SWBC DXer market. They are a supplier of advanced DSP-based communications equipment for government and industry, and the NIR-10 is a spin-off from their commercial product line. All their products are manufactured in their Raleigh plant.

In phone conversations and correspondence with JPS, they have proven to be a friendly, responsive company, interested in user-feedback on the NIR-10. They periodically send out helpful service bulletins, with details and schematics of upgrades and improvements the user can install. The upgrade and modification notices presumably reflect the fact that I was an early purchaser of the unit which initially came on the market in the Spring of 1991. Current models incorporate all previous upgrades.

DIGITAL SIGNAL PROCESSING– WHAT IS IT?

A digital signal is a group of pulses that are either "on" or "off". In digital terms, opposite conditions or amplitudes are indicated by the numerals 1 and 0. This results in a binary system with only two bits of information for each pulse, and variations for the digital signal are represented by changes in the 1 and 0 levels. Analog audio signals can be encoded in a digital form by sampling the signal at a very rapid rate.

Digital signals have a distinct advantage over analog signals in terms of less noise; it is relatively easy for a digital circuit to recognize just the two specific amplitude levels of a digital signal. The conversion from one

form to the other is done with analog-to-digital (A/D) and digital to analog (D/A) converters that change a continuously varying analog input voltage to a proportional digital output and vice versa.

The A/D and D/A converters, with DSP circuitry sandwiched in between, form the heart of the NIR-10.

In simple terms, the general purpose of the NIR-10 is the conversion of analog signals to the digital domain, manipulation of these signals digitally using the DSP chip, and conversion of the results back to analog. DSP processings acts to differentiate the desired speech components (in AM/SSB) from the rest of the incoming signal (i.e. it reduces the amplitude of the noise) in the noise reduction mode. In the bandpass mode it acts as a super-selective DSP audio filter with switchable bandwidths, primarily to enhance CW and RTTY reception.

DESCRIPTION

The NIR-10 is a compact unit that measures only 2" high, 6" wide, and 6" deep and it is housed in a sturdy aluminum case. All front panel markings are silkscreened in white on satin-finish black paint.

Front panel controls consist of POWER, MODE (NIR, Bandpass, Bypass), BANDWIDTH (Wide, Medium, Narrow), NIR LEVEL/BANDPASS SHIFT (depending on position of MODE switch), and VOLUME. Automatic Het Removal is available through a special combination of settings (discussed later). Also present is an audio peak-reading indicator LED and a 1/4" mono/stereo headphone jack.

Hookups found on the rear panel are female RCA jacks for AUDIO OUTPUT and AUDIO INPUT. REMOTE BYPASS and INVERTED REMOTE BYPASS connections are also available for radio amateurs who want to monitor their own transmitted signal through the NIR-10.

A 2.5mm coaxial jack for +11 to +15vdc power is used. The DC power can be provided from associated equipment or by an optional AC-to-12vdc adapter available through the manufacturer.

The NIR-10's components are mounted on a dense, high quality double-sided circuit board which is dominated by a 40 MHz digital signal processing chip. This component performs all DSP functions other than the A/D and D/A conversions. Two EPROM chips contain voice recognition software that acts upon the digitized signal, which is temporarily stored in two static RAM chips.

Although well built, the NIR-10 presents only an average appearance. Cheap knobs and plain, blocky front panel lettering contribute to an inexpensive "MFJ" look which is not in keeping with its price class.

Ergonomics suffer, too. The volume control is maddeningly close to the headphone jack, making operation difficult. Also, a monaural headphone's plug must be inserted only part-way since the NIR-10's headphone jack is not of the proper type to work with either mono or stereo headphones with the plug fully seated. I constructed a patch cord for adapting my headphones to the rear panel AUDIO OUT jack of the NIR-10; this allows easy volume control operation when using headphones and the awkward jack/plug situation is avoided.

A final drawback in the area of ergonomics is the arrangement of the three possible positions of the MODE switch. BYPASS would logically be in the center position, but instead it is found at the lowest of the three positions. While in NIR mode you must cycle through BANDPASS just for a quick check of what the audio sounds like in BYPASS.

BYPASS mode, incidentally, *does not* leave the audio unaffected. There is a definite roll-off of bass and treble frequencies during BYPASS. The logic of this circuit design escapes me; it appears to defeat the purpose of this kind of control. The NIR-10 should be completely removed from the audio chain (or modified with an additional switch) if you wish to listen to full fidelity from the international SW broadcasters and local MW stations.

The owner's manual gives all necessary information for hook-up and operation of the NIR-10. A complete audio section and power supply schematic is included, and also a simplified DSP section schematic. The technical description of the NIR-10 is adequate, but those who desire a more thorough look at this unique accessory's theory of operation will be left wondering.

INSTALLATION

Hooking up the NIR-10 is simple. All that is required is a patch cord between your receiver's headphone jack or external speaker connection and the AUDIO INPUT of the NIR-10. The tape record output of your receiver is NOT suitable; the audio level needs to be easily adjustable by the receiver's volume control while the NIR-10 is in use. Connect an external speaker to the AUDIO OUT connector or use headphones to listen to the processed audio.

Initially, the NIR-10 needs the audio input level set correctly via the receiver's volume control. The input is adjusted so that the peak-reading LED flickers on voice peaks, or the pulses of received CW or RTTY. A steadily glowing LED means the input to the NIR-10 is set too high, and audio distortion may result.

OPERATION

Three basic modes of operation are available to the DXer: NIR (Noise and Interference Reduction), BANDPASS, and Automatic Hetrodyne Removal (operates during BYPASS or NIR mode).

NIR mode offers a variable level of noise reduction, controlled by the NIR LEVEL/BP knob. Turning this control clockwise yields a greater and greater amount of white noise reduction (up to 20 db, according to manufacturer specifications).

The best setting of the NIR LEVEL depends on the signal-to- noise (S/N) ratio, the type of any interference or noise present, and the DXer's own preferences. There are situations where listenability ("how pleasant is the audio?") is preferred over intelligibility ("how well are the words understood?").

There are limits to the amount of noise reduction achievable with the NIR-10. A signal heavily corrupted by noise (S/N ratio approaching 0 db, for instance) may actually be reduced in quality by use of the NIR mode. Some of the information that characterizes speech is irretreivably lost before it reaches your receiver, and the NIR-10 cannot always improve intelligibility simply by reducing noise. Noise may be reduced, but audio "holes" begin to appear in the desired signal.

In addition, any noise remaining after reduction has an "electronic" sound that's difficult to describe. Quiet, almost musical tones are heard in rapid succession in the background of the desired signal whenever processed noise remains. According to the owner's manual, this is not an artifact introduced by digital processing but is all that's left of the original input noise. It has been "de-randomized" to a degree, and occurs in brief bursts. It often sounds unnatural, and can detract more from intelligibility or listenability than the original noise and interference in the signal. With high levels of noise reduction on a poor quality signal, greater amounts of this residual will exist at the output.

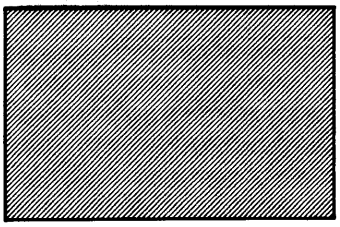
In general, the NIR mode is quite useful and serves to improve signal quality in a way that no other receiver accessory can. High-pass filters can fight hiss and noise to an extent, but their reduction of the higher audio frequencies can also eliminate some of the voice information in a signal. The NIR-10's software and DSP circuitry reduces noise and interference in a totally different fashion, by recognizing speech and reducing the amplitude of all signals which are not a part of the speech information. At times, I have heard white noise almost totally "melt" away, leaving a much more readable signal. I have never found the NIR-10 (in NIR mode) clarify an *unreadable* signal to the extent that it became readable; a certain amount of voice information is necessary in the first place for the NIR-10 to operate.

Often a slow AGC setting on the receiver gives better results with less breakup of the signal while in NIR mode, allowing a higher NIR LEVEL setting.

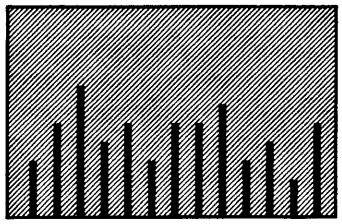
The NIR-10 was reviewed by Peter Ferrand in the May 1991 issue of *73 Amateur Radio Today* magazine. I highly recommend this review; it includes two interesting oscilloscope screen photos of the NIR-10 in action. These photos clearly illustrate how the unit can improve signals cluttered with power line noise.

The following graphics give my subjective visual interpretation of the effect the NIR-10 can have on signals in the Noise and Interference Reduction mode:

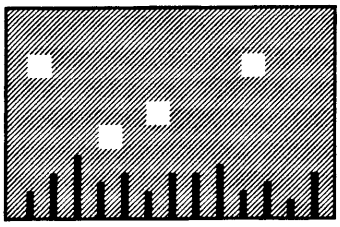
Ideal signal without interference



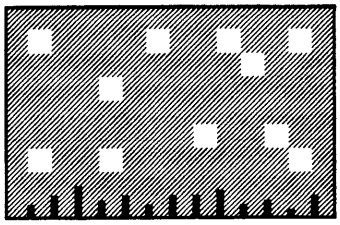
Signal with interference



Signal with interference reduced by NIR mode. Some audio "holes"-- not all information recovered.



Signal with interference greatly reduced by NIR mode. Increased audio holes" affect intelligibility.



I've found that the NIR mode performs best in the area of white noise reduction, but it also reduces ignition noise, powerline noise and CW/RTTY interference. Any form of interference that is of a repetitive nature or constant tone can be reduced to some extent by the NIR- 10. Static crashes, which are random impulses, are affected very little by the NIR-10.

The use of NIR mode reduces operator fatigue when attempting to interpret noisy, interference-plagued signals for a prolonged time. I've found lengthy DX sessions definitely less tiring when using the NIR-10. However, the constant adjustment of its various controls makes bandscanning difficult; the slight time delay of the DSP circuitry causes the NIR-10's audio to lag behind the receiver tuning. It is much easier to tune in BYPASS and then go into the NIR or BANDPASS mode when an interesting signal is found.

Surprisingly, the NIR-10 can reduce noise and interference while instrumental music is being received (unless the NIR level is set at an excessive level which breaks up the audio). I can only conclude that the speech recognition software in the unit is not sophisticated enough to differentiate music FROM speech, but can separate music AND speech from noise.

The NIR-10 works well in an audio processing "loop" with the Multi-band AM Pickup (MAP) unit from Kiwa Electronics. The result is better intelligibility than with the NIR-10 alone. The MAP works off the receiver's 455 kHz I.F. frequency and improves AM or ECSS reception before the signal is demodulated and passed along to the NIR-10 for audio processing.

Because the NIR-10's input is audio, it can work with other sources such as a cassette tape recording. I often record DX signals "raw" without any audio processing, for later playback through the unit, experimenting with various NIR LEVEL and BP SHIFT settings.

The NIR-10 has no record output jack, but it is possible to use the two outside lugs of the volume control potentiometer as a constant level audio output. Tapping this point in the circuit, I've recorded processed signals for playback again through the NIR-10. Only occasionally has this second pass of digital processing yielded further improvement, but it is a technique worth trying.

BANDPASS mode in the NIR-10 offers three fixed audio filter bandwidths: narrow (200 Hz), medium (600 Hz), and wide (1800 Hz). The center frequency of each is continuously variable from 300 Hz to 3400 Hz. BANDPASS is a utility DXers delight; it is easy to use and works extremely well. It is intended to enhance CW, RTTY, SSTV, and packet at the narrow and medium settings, and voice transmissions in the wide position. Because the NIR-10 operates in the digital realm, the resulting bandpass has steep skirts and superb ultimate rejection (>60 db) that equal or surpass those of the best switched-capacitor or active analog filters (according to the manufacturer).

Any narrow, steep-skirted filter-- digital or analog-- is subject to "ringing". The NIR-10's narrow bandwidth is the equivalent of a resonant high-Q circuit, and can display a rasping sound when a signal is placed on the band edge. This rasping is the digital equivalent of ringing. However, the NIR-10's digital filtering in BANDPASS mode surpasses that of analog filters in that no ringing or other irregularities occur with the signal placed in the passband.

The first release of the NIR-10 provided a wide bandwidth of 1500 Hz, not completely suitable for voice modes. JPS Communications later changed this setting to 1800 Hz wide in Version 4.2 of the software, and it is now very useful for DXing SWBC stations. The setting of the BP SHIFT control is critical and a small adjustment of the center frequency makes a large difference in intelligibility (a geared vernier control would be helpful here!). BANDPASS mode in the wide setting offers another way to reduce effects of noise and interference on voice signals, but NIR and BANDPASS cannot be used simultaneously.

The medium and narrow positions are very effective for isolating individual RTTY and CW signals. I've had astounding results pulling single CW signals out of horrendous pile-ups, splatter, and other interference. DXers who tune RTTY, packet, fax, and SSTV will find the NIR-10 very useful in both NIR and BANDPASS modes.

The Automatic Het Removal mode operates well and will even remove multiple tones (i.e., RTTY interference is reduced to a pattern of soft clicks, leaving a much more intellible signal). This mode removes tones (hetrodynes) from tune-ups, broadcast stations, CW, RTTY, or any tone which last longer than 3 milliseconds. It is a curious experience to bandscan in ECSS with the Automatic Het Removal activated; all hetrodynes are silenced and the audio simply comes and goes as you tune across a station.

Automatic Hetrodyne Removal mode is controlled by the Bandwidth (BW) switch. This mode is activated by placing the BW switch in the WIDE position (all the way up) in either NIR or BYPASS modes. Automatic het removal is not possible in the BANDPASS mode. Here the controls all work normally, where the BW switch controls the bandwidth of the tuneable passband filter.

This mode has a curious effect on music and it will totally remove many sustained notes. A rousing rendition of *Amazing Grace* on radio station KVOH was nearly turned into *The Sound Of Silence.*

This feature performs best when tuning SSB voice signals in medium and narrow receiver bandwidths. I've noticed that voice signals may suffer distortion as the NIR-10 seeks out tones and hets to remove if the receiver is in AM mode with a wide filter.

PRICE AND ORDERING INFORMATION

The NIR-10 Noise and Interference Reduction Unit costs $395.00 (US), which includes surface shipping. If you do not possess an appropriate AC adapter (12vdc at 1 amp.), JPS can supply one for $12 when ordered with the unit. The NIR-10 is covered by a 90 day warranty.

To order the NIR-10, contact: JPS Communications, Inc., P.O. Box 97757, Raleigh, NC 27624-7757 USA. Phone: (919) 790-1011. FAX phone number: (919) 790-1456.

THE BOTTOM LINE

Is the NIR-10 worth nearly $400? This amount is definitely a significant outlay for most DXers. However, since the NIR-10 is currently a one-of-a-kind product–the first of its type–there is no other similar device to compare it to. New technologies cost a premium, yet if you're willing to wait there will certainly be less expensive, even better performing noise and interference reducing digital accessories available in the future.

If you monitor various utility transmissions as well as broadcast stations you will find the NIR-10 a valuable accessory, and will use all its capabilities on a regular basis. Only one of the unit's three BANDPASS filters will be of value to DXers who stick to voice modes. They will find it harder to justify (as I do) the NIR-10's cost.

At this early stage in the evolution of DSP, any evaluation of the cost/performance equation must ultimately be left to the individual. The reviewer of the *73 Amateur Radio Today* article mentioned earlier concluded that the unit is definitely worth having if your listening or DXing frequently involves extended periods in front of the receiver.

JPS Communications is an established company which has impressed me with their customer service and dedication to improving their product. It's steep price aside, the NIR-10 is a state-of-the-art performer that has given us a glimpse into the future of audio processing for the DX hobbyist.