NIR-12

Professional
Dual DSP
Noise / Interference
Reduction Unit

Instruction Manual

JPS Communications, Inc.

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SECTION 1

**BRIEF
DESCRIPTION**

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The NIR-12 is an advanced audio signal processor designed to provide the user with maximum flexibility to eliminate most types of interference from voice, CW and data transmissions. The unit uses dual Digital Signal Processors (DSP) to provide simultaneous bandpass operation, noise reduction and multiple tone/heterodyne removal. The Notch filter eliminates **all** tones, including tune-ups, foreign broadcast carriers, CW, RTTY, etc. A multi-layer printed circuit board provides superior shielding to virtually eliminate rf radiation from the DSP data bus. Two methods of noise reduction are provided in the NIR-12, Spectral Subtraction (NIR®) and Dynamic Peaking, to give the operator the best audio noise reduction possible. The NIR-12 connects between the audio output of a receiver or transceiver and an external speaker. The audio from the receiver is processed internally before being amplified and fed to an external speaker. The following sections explain how the unit operates and how the controls function.

For experimenters, access to the dual DSPs is provided via RS 232 on an internal header. Section 8 of this manual describes how to use this input to generate your own filters and develop other uses for the dual DSP chips.

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**NOISE REDUCTION
MODES**

NIR® MODE

The NIR® MODE of noise reduction automatically enhances voice signals by recognizing speech and reducing the amplitude of all signals which are not part of the desired speech information. The algorithm is developed primarily to recognize the characteristics of human speech and the

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subsequent relationships of speech frequencies relative to non-speech frequencies. The detected speech frequencies are allowed to pass, while non-speech frequencies may be reduced using the front panel NIR® control. Because of their syllabic nature, CW and data frequencies are also allowed to pass with minimal degradation. In this mode, the NIR-12 removes noise and heterodynes within the selected passband with little or no corruption of the desired signal. This mode is particularly effective at reducing impulse noises, such as automotive ignition noise, power line noise, computer noise, static, etc. The amount of noise reduction is continuously variable from zero to maximum by means of the NIR® LEVEL control on the front panel of the unit. This allows the user to manually adjust the noise reduction level to give the best intelligibility. By turning the NIR® LEVEL control fully clockwise to the AUTO position, the proper noise reduction level is selected automatically, based upon the signal to noise ratio of the received signal. The NIR® mode of noise reduction is engaged by turning the NIR® in a clockwise direction. Turning the NIR® control fully counter-clockwise disables the NIR® mode. NIR® mode may be operated in conjunction with any or all other modes simultaneously.

DYNAMIC PEAKING MODE

The Dynamic Peaking mode of noise reduction provides good reduction of white/pink atmospheric noise when receiving voice, CW or data. It forms dynamic bandpass filters around coherent frequencies, such as the fundamental and harmonics of speech, CW notes, RTTY MARK and SPACE tones, etc., within the audio passband. This method of noise reduction is less effective on impulse noises than NIR® mode, but both noise reduction methods may be used together, if desired. A three

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position slide switch located at the rear of the unit allows the operator to adjust the peaking factor of the Dynamic Peaking Mode to give the smoothest sounding performance. Increasing the PEAK FACTOR provides more actual noise reduction, but may also give a "surging" quality to the recovered audio. Reducing the PEAK FACTOR lowers the noise reduction but also provides the best sounding audio. The Dynamic Peaking noise reduction is engaged by pressing the DYN PEAK pushbutton. When this mode is engaged, the green LED beneath the switch will be illuminated. The DYN PEAK mode may be operated with any or all other modes simultaneously.

NOTCH FILTER

The spectral notch filter provides cancellation of multiple tones or whistles from tune-ups, adjacent channel carriers, CW, RTTY, or similar signals without interfering with voice signals. The Notch filter will remove any number of offending tones or heterodynes automatically. The filter is engaged by pressing the NOTCH pushbutton. When the Notch feature is operating, the green LED beneath the NOTCH switch will be illuminated. The Notch may be operated in conjunction with any or all other modes simultaneously. For CW or data use, the NOTCH filter must be turned off or the received tones will be removed from the audio.

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**BANDPASS
FILTER**

FREQ and BW

The audio bandpass filter in the NIR-12 is a very steep skirted Finite Impulse Response (FIR) type providing linear phase in the passband and minimum passband ripple. The bandwidth of the filter is selected with the BW control, and is continuously variable from 50 Hz to 3400 Hz in 100 Hz increments, with a minimum bandwidth of 50 Hz. Markings on the panel give approximate bandwidths for various modes of operation, such as CW, data (D), TV and voice (V). The bandwidth in Hz is also screened onto the front panel. The center frequency of the chosen filter is variable in 50 Hz increments from 200 to 3400 Hz and is selected with the FREQ control. Markings on the front panel also give approximate center frequency locations for CW, TV, and data (D), and actual center frequency in Hz. The data center frequency marked is for US operation. For European operation, the center frequency should be set at the 1500 Hz mark.

When the BW control is set fully CW at the 3400 Hz mark, the full audio bandwidth is provided and the FREQ control is disabled. If the FREQ control is set at the 200 Hz mark (fully counter-clockwise), the BW control will provide a low pass filter characteristic with the cut-off frequency increasing as the BW control is moved in a clockwise direction. Likewise, if the FREQ control is set at the 3400 Hz mark (fully clockwise), the BW control will provide a high pass filter characteristic with the cut off frequency increasing as the BW control is moved in a counterclockwise direction from maximum (3400 Hz). The BANDPASS filter skirt selectivity provides excellent rejection of adjacent channel chatter or interference

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from other close-in stations. The delay through these filters is less than 19 milliseconds, so they operate in "real time", and may be used for any mode, including AMTOR and PACTOR ARQ modes.

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SECTION 2

QUICK OPERATION

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This section lets the operator get on the air with the NIR-12 as quickly and as simply as possible. Refer to the front and rear panel views (Figures 1 and 2) and the connection diagram, Figure 3. See the following sections of this manual for more detailed operation and connection information.

CONNECT POWER

The NIR-12 requires power from a nominal +12VDC source. Plug in an AC to 12VDC adapter or wire the plug supplied with the unit to your station +12VDC power source. Note that the center pin of the coaxial power connector is positive. Check polarity before plugging the power connector into the NIR-12 DC IN jack (J6). The unit is protected against reverse polarity, so no damage will occur, but the unit will not operate if the correct polarity is not observed. **The power source selected must have a 1 Ampere current capacity for proper operation of the unit.** The NIR-12 DC IN jack is a coaxial type, 2.5mm ID, 5.0 or 5.5mm OD, center positive (Radio Shack 274-1568 or 274-1573).

CONNECT AUDIO INPUT

Connect the Speaker Output (or external speaker output) of your receiver to the AUDIO INPUT jack (J4) of the NIR-12. This jack is an RCA Phono type, NOT a 1/8" phone jack. If you wish to use the receiver LINE output or the PHONE output, you must change the internal jumper JP1 to the HI impedance position. See Figure 7.

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CONNECT SPEAKER or HEAD-PHONES

Connect a 3.2Ω or greater speaker to the SPEAKER OUTPUT jack (J2). If desired, two 8Ω speakers may be connected in parallel for maximum audio output. The NIR-12 SPEAKER OUTPUT jack is an RCA Phono type, NOT a 1/8" phone jack. Or you may plug your headphones into the rear panel headphone jack. This is a stereo jack so that either mono or stereo headphones may be used. For stereo phone use, plug the headphone connector in all the way. For mono phone use, plug the connector in all the way, then pull the plug out one notch.

TURN ON POWER

Now press the NIR-12's POWER pushbutton. The yellow LED below the switch should illuminate. If it doesn't, check your power source, connections and polarity.

INITIAL SETTINGS

For voice use, set the BW control at the 3400 Hz position, and set the FREQ at 200 Hz. Place the NIR control at the fully CCW position and adjust the VOL control to about mid-range. Make sure the NOTCH and DYN PEAK pushbuttons are not pressed at this time.

RADIO SETTINGS

Turn on your receiver and tune in a voice station. Adjust your receiver's volume control so that the SIGNAL LED on the NIR-12 flashes occasionally on voice peaks. This sets the proper audio input level to the NIR-12. When retuning to a different station, you may wish to readjust the receiver volume up or down to get the SIGNAL LED to flash occasionally. This setting provides the maximum dynamic range for noise reduction. Leave

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POWER SWITCH
PUSH ON/OFF

INPUT SIGNAL
LEVEL LED

SETS FILTER
CENTER FREQ

SETS FILTER
BANDWIDTH

TURNS ON
INTELLI-NOTCH
FILTER

TURNS ON
DYNAMIC PEAKING
NOISE REDUCTION

CONTROLS NIR MODE
NOISE REDUCTION
PROCESSING LEVEL

AUDIO OUTPUT
VOLUME CONTROL
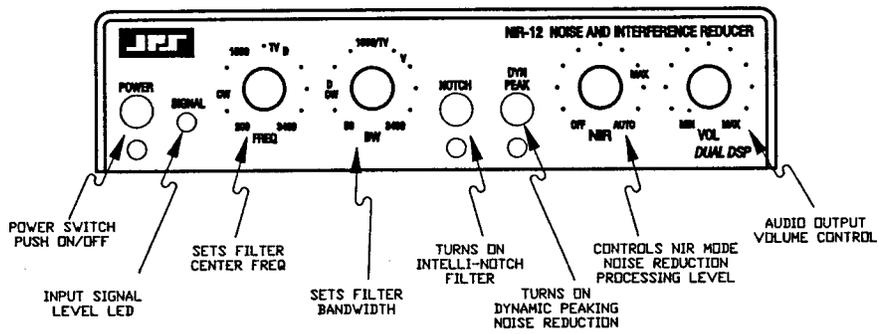
Figure 1 - Front Panel View

STEREO
HEADPHONE
JACK

AUDIO OUTPUT
TO EXTERNAL
SPEAKER

600 OHM
OUTPUT TO
MODEM

GROUND LUG
TO GROUND
CHASSIS

RECEIVER
AUDIO

UNIT BYPASSED
WHEN THIS INPUT
IS PULLED LOW

ADJUSTS
AGGRESSIVENESS OF
PEAKING ALGORITHM

+12VDC INPUT
CENTER (TIP)
IS POSITIVE
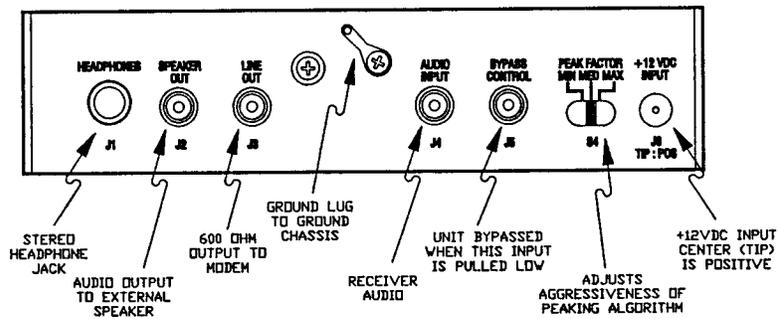
Figure 2 - Rear Panel View

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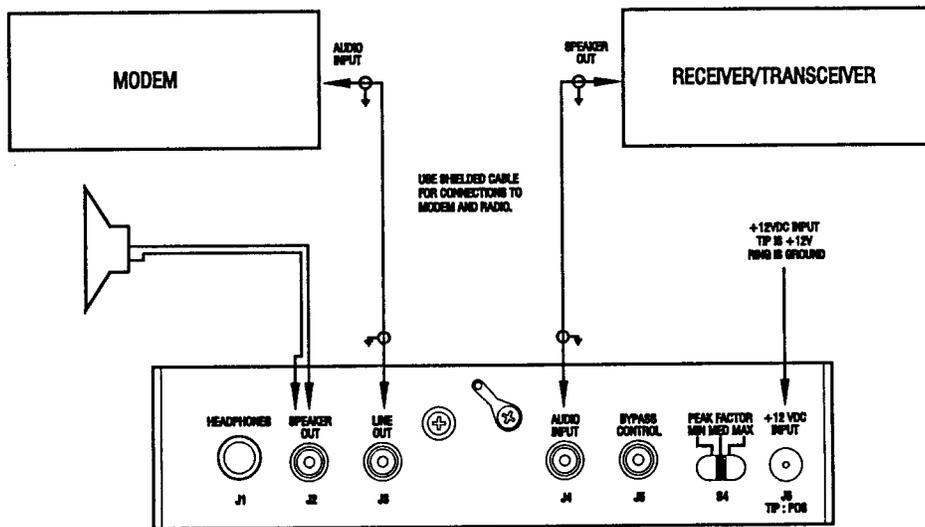
Figure 3 - Connection Diagram

your radio's volume control at this point and adjust your listening level only with the NIR-12's VOL control. <u>If you have an internal speaker in your receiver, make sure that you turn it off so that you are listening only to the output from the NIR-12.</u>

NIR® MODE

Adjust the NIR-12 VOL control for a comfortable listening level. The NIR-12 is now operating essentially in a bypass mode with a bandwidth of about 3200 Hz. You are now listening to the unprocessed audio from your receiver. Now find a noisy station or just tune to background noise. Increase the NIR®control in a Clockwise (CW) direction while listening to the noise level. The noise will decrease and fade into the background as the control is rotated CW. For most operation, setting the control at about 10 o'clock gives the best compromise noise reduction. Adjusting this control when listening to various signals at differing signal to noise ratios will soon educate the user as to the best position for this control versus signal to noise ratio of the received signal. If automatic adjustment of the NIR® processing level is desired, merely turn the NIR® control fully CW to the AUTO position. In this position, the processing level is determined automatically by the DSP based on measured signal to noise ratio of the received signal.

DYNAMIC PEAKING

Return the NIR® control to its fully CCW position. Listen to the background noise. Press the DYN PEAK pushbutton and listen to the reduction in background noise. Hiss and other constant, non-impulse noise will be reduced 6 to 20 dB. If a voice signal is being heard, you may

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wish to experiment with the rear panel PEAK FACTOR switch to get the best sounding resultant audio. NOTE: When the DYN PEAK pushbutton is engaged, the green LED beneath the switch will be illuminated. The noise reduction in the DYNAMIC PEAKING mode is automatically calculated by the DSP based on the settings of the PEAK FACTOR switch, which determines the aggressiveness of the noise reduction algorithm.

NOTCH MODE

Now turn off the DYN PEAK switch and tune in a tone or heterodyne. Press the NOTCH pushbutton and hear the tone disappear. Tune in a CW station. The Notch filter should remove the tone from the CW signal, leaving only short clicks as the CW tones arrive.

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│     SECTION 3       │
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│    CONNECTIONS      │
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This section gives detailed information about the connections to the NIR-12. The unit is very simple to connect and use, but for best results, the guidelines given here should be followed.

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POWER REQUIREMENTS

The NIR-12 operates from +11VDC to +16VDC. Audio peaks may push peak current consumption to 1 Ampere, so an adapter or power source with at least 1 A capacity is required. If a station supply is not available, or the existing supply is inadequate, JPS offers an optional power adapter rated at 1 A for small additional cost. The mating power connector is supplied with the unit. (Radio Shack 274-1568 or 274-1573.) It is coaxial 2.5mm ID, 5.0 or 5.5mm OD, center positive.

VEHICULAR OPERATION

The NIR-12 may be operated directly from the power system of any 12V negative ground vehicle.

REAR PANEL CONNECTORS

(See Figure 2)

AUDIO INPUT

The NIR-12 may obtain its audio input from the speaker output, line output, or headphone output of almost any kind of receiver or transceiver. Its audio input is AC coupled, with internal jumper-selectable high (47k) or low (22 ohm) impedance. For use with a receiver or transceiver speaker output, internal jumper JP1 (see Figure 6) should be set to the LO position

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to provide a reasonable load impedance for the receiver's driver circuit. All units from the factory are set to the LO position. If the line output, phone jack or other high impedance output is desired as the audio source, set jumper JP1 to the HI position. The audio input of the NIR-12 is protected against overloads up to $\pm$50V.

The front panel SIGNAL LED makes setting the input level very easy: Tune in a strong station and simply advance your radio's volume or audio level control until the SIGNAL LED flashes occasionally on voice peaks.

$\boxed{\textbf{NOTE}}$

For best operation and maximum dynamic range, the NIR-12 should have a relatively constant input audio level. In most cases, this means that once set per the previous paragraph, the receiver volume control should be left alone, and the listening level controlled with the VOL control on the NIR-12. However, in the world of noise, there are no hard and fast rules, so adjustment of the receiver volume up or down from the previous setting may yield improved results. However, the operator should be cautioned against overdriving the input (more than an occasional SIGNAL LED flash), since performance will not be improved and only increased audio distortion may result. Experiment with settings on your receiver as well as the NIR-12 to get the best results for your particular listening enjoyment. Just remember that it is virtually impossible to create intelligibility where none exists, so you may encounter signals that just cannot be read regardless of the degree of noise reduction.

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SPEAKER OUTPUT

The speaker output (J2) is the main high power audio output from the unit. It can furnish about 4W into a 3.2Ω speaker or about 2W into an 8Ω speaker. Two 8Ω speakers can be connected in parallel if more audio power is desired. This output is protected against open or short circuits.

LINE OUTPUT

The LINE output (J3) is a constant level output designed for use with modems, telephone patches or other 600Ω or higher impedance peripherals. Its output level is not affected by the NIR-12's VOL control. If the receiver is set up per instructions given previously, the LINE output level will be approximately -12 dBm open circuit, or -18 dBm into 600Ω.

HEADPHONE OUTPUT

This output is a stereo phone jack (J1) connected to the speaker output through a resistive divider to prevent headphone overdrive. It will satisfactorily drive 8Ω and higher impedance headphones.

NOTE

A mono phone plug inserted all the way into the stereo jack will short both channels and you will get no audio (no damage will occur, however). A mono plug may be used by inserting it fully, then pulling it out one detent. If you prefer not to do this, a stereo to monaural adapter is available from Radio Shack.

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BYPASS

This input (J5) may be used to bypass the NIR-12 whenever the transmitter is keyed. This may only be required if the desired CW passband and the sidetone frequency do not overlap so that the sidetone can be heard. Or if the NIR®mode is in use while operating on CW. To use the BYPASS, connect this jack to the transceiver keyline or the line that is used to key the rf linear power amplifier. See Section 7 of this manual for further information.

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SECTION 4

CONTROLS

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This section explains the operation of each of the NIR-12 controls. See Figures 1 and 2 for views of the front and rear panels of the NIR-12.

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FRONT PANEL CONTROLS

POWER SWITCH

The POWER switch controls the main power to the unit. When power is applied and the switch is energized, the yellow LED beneath the switch will be illuminated.

SIGNAL LED

The SIGNAL LED flashes when the audio input level reaches a point somewhat below the maximum signal that the NIR-12 can handle without producing distortion. Using this indicator as a guide, the audio input level may be adjusted to take advantage of maximum dynamic range, yet avoid overload. The proper input audio setting (generally established by the receiver's volume control) is obtained when the SIGNAL LED flashes occasionally on voice peaks. This LED should NOT be on continuously or audio distortion may result.

FREQ CONTROL

The FREQ control establishes the center frequency of the bandpass filter. Markings on the front panel around the control show approximate frequency and desirable filter positions for various modes of operation, such as CW, SSTV, or data. The filter center frequency is adjustable from

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200 to 3400 Hz. When the FREQ control is set to 200 Hz, the BW control provides a low pass filter characteristic, with the cutoff frequency increasing as the BW control is rotated in a clockwise direction (See Figure 4). When the FREQ control is set to 3400 Hz, the BW control provides a high pass filter characteristic, with the cutoff frequency increasing as the BW control is rotated in a counterclockwise direction from maximum (See Figure 5). Whenever the BW control is set fully CW to the 3400 Hz position, the FREQ control is disabled and the full audio bandwidth is available.

BW CONTROL

The BW control establishes the bandwidth of the bandpass filter. Markings on the front panel around the control provide approximate audio bandwidth and recommended filter widths for various modes of operation, such as CW, data, SSTV or voice. The filter bandwidth is variable from 50 Hz to 3400 Hz. As described in the paragraph above, using this control in conjunction with the FREQ control set at either end of its range will provide high pass or low pass filter characteristics. With intermediate settings of the FREQ and BW controls, a bandpass filter characteristic is obtained. Setting the BW control fully CW at the 3400 Hz position disables the FREQ control and provides the full audio bandwidth.

NOTCH SWITCH

When pressed, the NOTCH pushbutton energizes the spectral notch function to eliminate any number of offending tones or heterodynes. When energized, the notch filter removes ALL tones and whistles, including CW notes and RTTY MARK and SPACE tones. When the Notch filter is in use, the green LED beneath it will be illuminated. The Notch function may be used in conjunction with any other modes.

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DYNAMIC PEAKING SWITCH

The DYNAMIC PEAKING mode of noise reduction is energized by pressing the DYN PEAK pushbutton. This provides very good reduction of white noise (hiss) and similar noise types. For maximum noise reduction, this method may be used by itself or in conjunction with the NIR® mode, to solve particularly tough noise situations. A rear panel switch (S4) allows the operator to select the PEAK FACTOR (aggressiveness of the dynamic peaking mode) that provides the best sounding audio for the existing conditions. The switch is easily accessible at the rear and the setting may be changed at any time. See the paragraph on the PEAK FACTOR switch for further information. The Dynamic Peaking mode may be used simultaneously with any other mode.

NIR® CONTROL

The NIR® noise reduction control provides fully adjustable processing level and degree of noise subtraction. The operator may set the control for the best compromise between noise reduction and intelligibility. If too much processing is used on weak signals, intelligibility can actually suffer, and the control should be reduced in a CCW direction until the best intelligibility is obtained. Please keep in mind that the NIR-12 will not provide intelligibility where none exists, but will allow signals partially masked by noise to be successfully copied with a great deal of understanding. The normal setting for the NIR® control is at about 10 o'clock, where the best compromise is often found. An additional feature has been introduced in the NIR-12: AUTOmatic noise reduction level adjustment. This is placed into operation by rotating the NIR® control fully clockwise to the AUTO mark. In this position, the DSP calculates the signal to noise ratio of the received signal and adjusts the audio processing level for best operation. To disable the NIR® mode, merely

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turn the NIR® control fully counter-clockwise to OFF. The NIR® mode may be used with any other mode.

VOLUME CONTROL

The VOL control sets the audio output level at the speaker and headphone outputs of the NIR-12. It does not affect the audio output at the LINE OUTPUT connector.

REAR PANEL CONTROLS

(See Figure 2)

PEAK FACTOR SWITCH

The PEAK FACTOR switch, located on the rear panel next to the Power Input connector (J6), provides a Minimum, Medium and Maximum setting for the aggressiveness of the Dynamic Peaking noise reduction algorithm. The Minimum setting (farthest from the Power Connector) provides the smoothest audio at the expense of total white noise reduction, while the Maximum setting (closest to the Power Connector) gives the most noise reduction at the expense of audio smoothness. The Medium position gives a compromise between the other two positions. The switch positions may be changed at any time but are only effective when the DYN PEAK switch is energized.

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│   SECTION 5     │
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│   OPERATION     │
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This section explains the operating procedure using the NIR-12 and offers some hints for use with various types of signals and various types of noise.

NIR® MODE on VOICE

The NIR® mode is designed primarily to remove noise occurring in the presence of speech. The algorithm is designed to save speech frequencies while making all non-speech frequencies cancellable. The algorithm is broad enough to allow CW and data signals to pass as well as voice, while eliminating the noise. Some degradation of slow speed (<7WPM) CW may occur if the processing level is set too high, however. Adjustment of the processing level is provided via the NIR® control to allow the operator to set the degree of noise reduction to the point where the best intelligibility is obtained. An AUTO position is also provided on the NIR® control to give automatic adjustment of the processing level based on the measured signal to noise ratio of the received signal.

When the NIR® control is used manually, the best results will likely be obtained with the control at the 10 o'clock position, or thereabouts. Some adjustment from this point may be necessary to get the best operation for the existing conditions. A careful adjustment of this control should provide the optimum intelligibility setting for signals at or just below the noise level.

The NIR® mode may be used by itself or in conjunction with the NOTCH filter and/or the DYN PEAK mode. Any bandwidth may be selected for

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this operation. With this full flexibility, adjacent channel interference may be removed with the BANDPASS filter, and almost any noise type and/ or heterodyne may be removed with the NOTCH, DYN PEAK and NIR® modes.

Certain types of noise may contain some characteristics of speech, making them difficult to completely suppress. If you find a noise only partially suppressed, try reducing the audio level into the NIR-12. Please note that no noise reduction device can recover intelligibility where none exists, as in a voice signal grossly corrupted by noise. For signal to noise ratios of 0 dB or better, the unit does an exceptional job of eliminating noise from the desired signal. It can't however make an S2 voice signal fully readable in an S5 noise level.

DYN PEAK MODE on VOICE

The Dynamic Peaking mode of noise reduction is designed to peak up any correlated information in the audio passband. It reduces noise by forming dynamic bandpass filters around correlated information, thus automatically reducing the bandwidth to the minimum necessary to pass the information. The DYN PEAK mode is most effective on purely random noise, such as white or pink noise, and less effective on impulse noises. When more periodic noise types are encountered, such as ignition noise or power line noise, the NIR® mode or a combination of NIR® and DYN PEAK modes may be more effective. The PEAK mode may be quite effective when used to clean up CW or data signals, since it will peak on the coherent tones, but reject the surrounding white noise. When used with a narrow CW filter position, the DYN PEAK function can provide noise-free, single-signal CW reception.

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**DYN PEAK & NIR®
MODES TOGETHER
on VOICE**

For the optimum noise reduction of both white noise and impulse noise, both the DYN PEAK and NIR® modes may be used together. The NIR® control provides adjustment of the Spectral Subtraction noise reduction so that the best intelligibility setting can be made. In many cases, placing the NIR® control fully clockwise into the AUTO mode will give excellent, hands-free noise reduction operation.

The smoothest speech audio with superb noise reduction is obtained when both Dynamic Peaking and the NIR® mode are being used together, but neither is trying to do the entire job by itself. Set the PEAK FACTOR at MIN, push in the PEAK button and set the NIR® control at about 10:00. (Try the NIR® in AUTO mode, as well.) In most cases with these settings, almost all noise and artifacts will be removed, leaving only the voice.

**NIR® MODE on CW
and RTTY**

While the NIR® mode is primarily designed to enhance speech, it will also perform quite well on CW and RTTY modes. However, if the CW speed is below 7 WPM, the spectral subtraction may interpret the tones as interference and attempt to remove them, particularly if the NIR® control has been set toward MAX. Reducing the NIR® processing level will generally clear this problem. The NIR® mode has about a 130 millisecond processing delay, so the rear panel BYPASS connector should be tied to the transceiver keyline to put the unit into "real time" when transmitting to prevent delay to the transceiver CW monitor tone.

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DYN PEAK on CW   The DYN PEAK mode may be even more useful on CW, since it tends to peak on the CW tone and reject any atmospheric noise contained within the CW filter passband. For best operation and minimum interference from noise, the filter bandwidth should be set narrow enough to provide comfortable listening and also prevent adjacent channel signals from interfering with the operation of the peak function. The DYN PEAK will peak ALL coherent signals within the filter passband, so the filter should be centered around the signal you wish to receive to the exclusion of all others. You may note that by reducing the filter bandwidth, enough noise will be removed in the process so that additional noise reduction is not necessary.

DYN PEAK on DATA   The DYN PEAK mode is also very useful for reducing noise on data signals, such as RTTY, AMTOR, PACTOR, Packet, etc. The dynamic peaking mode operates in "real time" so no discernible delay is noted and transmit/receive timing, particularly important with ARQ data modes, is not affected. The peaking function will peak the data tones and reject the atmospheric noise received within the filter passband.

NIR®/DYN PEAK on STATIC CRASHES   A static crash causes two problems, both of which are annoying and disrupt communications: First, a static crash of any reasonable duration is offensive to the ears; Second, the receiver AGC is often driven to its limit and requires a relatively long period of time to recover. During this AGC recovery period, the desired signal is momentarily "lost". The NIR-12 can often provide significant reduction of the static impulse noise, and

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manipulation of the receiver's AGC characteristics can allow faster recovery of the desired signal. To counter the effects of a static crash, turn on the DYN PEAK mode and set the NIR® control at about the 10:00 position. Now change the receiver AGC characteristic from SLOW to FAST. The NIR® and DYN PEAK modes together will reduce the long static crashes to "pops" of about 150 millisecond duration, while the FAST AGC will allow the receiver to recover rapidly. The result will be relatively clear audio with "pops" in the background. If your receiver does not allow the AGC characteristic to be changed, try reducing the rf gain to partially disable the AGC and then increase the receiver audio volume.

BANDPASS MODE

The audio filter characteristic of the NIR-12 is established by the FREQ and BW controls. The BW control determines the actual bandwidth of the steep-skirted FIR filter, and the FREQ control sets the center frequency of the filter where the operator wants it. For instance, if operation on Slow Scan TV is desired, setting the FREQ and BW controls at their respective TV marks on the front panel, provides the proper bandwidth and filter frequency location for SSTV operation (1000 Hz to 2500 Hz). Setting the BW control at the CW mark provides a CW filter of about 200 Hz width. If the FREQ control is also set to its CW mark, the filter is centered at about 800 Hz. The CW bandwidth can be further reduced to 50 Hz and the center frequency moved lower or higher than the 800 Hz setting, as desired. For optimum reception of EME signals or other very weak, but slow, CW signals, set the bandwidth as narrow as desired and turn the center frequency down in the 300 to 400 Hz range. The bandpass filters in the

NIR-12 operate in "real time", so there is no discernible delay between input and output audio. Note that as the audio bandwidth is decreased, the noise bandwidth is likewise decreased, so that the desired signal in the narrower bandwidth has much less noise interference than it had in the wider bandwidth. Using the PEAK or NIR® modes to further reduce noise can provide virtually noise free CW or data reception.

VOICE

For voice use, the "V" mark on the BW control gives a very sharp filter with about an 1800 Hz bandwidth. This normally gives the best compromise between rejection of adjacent channel interference and audio fidelity. The FREQ control can then be used to place the passband where desired by the operator. Initially, start with the FREQ control at the full CCW (200) mark and increase it in a clockwise direction. This will let the operator find the best filter center frequency location for eliminating adjacent channel "chatter" or other interference in the shortest time.

DATA

For use in most data modes, set the FREQ and BW controls on their respective "D" marks to obtain a filter 500 Hz wide centered at 2200 Hz. This is the proper setting for US operation. For operation in Europe, change the FREQ control to the "1500 Hz" setting while maintaining the BW filter at its "D" mark.

FULL BANDWIDTH, HIGHPASS AND LOWPASS FILTERS	If the BW control is set at "3400 Hz" (fully CW), the FREQ control is disabled and the full audio bandwidth, 200 to 3400 Hz, is realized. With the FREQ control set fully CCW, the BW control can be moved to provide a low pass filter characteristic, with the cutoff frequency roughly equal to the knob calibration setting. For instance, putting the BW control at the "1500 Hz" mark will give a LOW PASS filter with a 1500 Hz cutoff frequency. Likewise, if the FREQ control is set fully CW, the BW control can be rotated to adjust the bandwidth of a HIGH PASS FILTER. For all other positions of the FREQ control, a BANDPASS filter characteristic is provided. See Figures 4 and 5.

GENERAL OPERATING HINTS

Following are suggested settings for various operating modes. See Table 1.

VOICE

For voice use, set the BW control at the "V" position; set the FREQ control halfway between the 1500 Hz position and the "CW" mark. This establishes an 1800 Hz bandwidth centered at about 900 Hz. If noise or heterodynes are also being received, press the NOTCH pushbutton and either press the DYN PEAK pushbutton or advance the NIR® control to about the 10:00 position, or do both, to reduce the received noise. As mentioned previously, superb noise reduction characteristics are obtained when both PEAK and NIR® modes are used together, with the PEAK FACTOR set at MIN. Adjacent channel "chatter" or other interference may be reduced by decreasing the bandwidth (BW control) or varying the center frequency (FREQ control) of the filter to change the position of the very steep skirt cutoff. Some experimentation may be necessary to achieve the desired results.
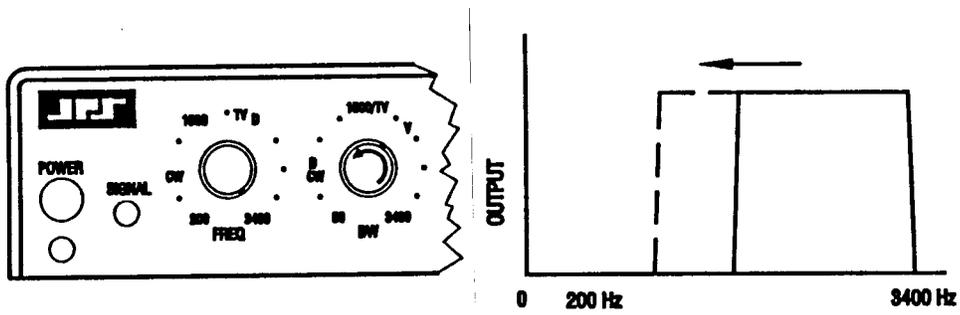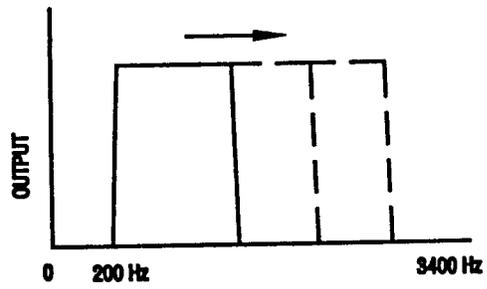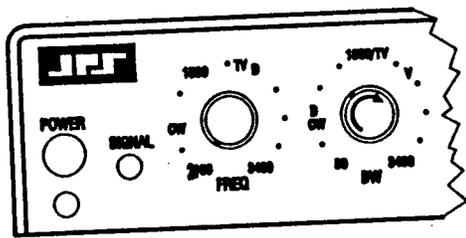
26

Figure 4 - Low Pass Filter Operation

Figure 5 - High Pass Filter Operation

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CW

For use on CW, set the FREQ control to the CW position and the BW just above the "D" mark on the front panel. This provides about a 600 Hz bandwidth and allows the operator to tune in the desired CW signal using his receiver. When the desired station has been set properly by the receiver, Slowly rotate the FREQ control until the signal is centered in the passband, then decrease the bandwidth by turning the BW control in a CCW direction until the only thing heard is the desired CW signal. Some slight readjustment of the FREQ control may be required to set the center frequency of the filter at the tone frequency desired by the operator. If noise is heard within the selected CW bandwidth, it may be removed by pressing the DYN PEAK pushbutton or by advancing the NIR®control until the noise disappears.

RTTY, AMTOR,
PACTOR &
Most Data Modes

For RTTY, AMTOR, PACTOR and most other data modes, set the FREQ and BW controls to their respective "D" positions. This provides a filter 500 Hz wide, centered at 2200 Hz. This is the proper setting for US operation. For European operation, set the FREQ control to the 1500 Hz position. To remove noise within the filter passband, press the DYN PEAK pushbutton.

Packet

Most Packet users prefer to operate at a center frequency of 1800 Hz, so the FREQ control should be set one mark above the "TV" mark, while the BW control is set at the data "D" position. As noted above, use of the DYN PEAK pushbutton will remove noise from the filter passband. For other packet center frequencies, the FREQ control can be used to set the data filter center frequency where desired by the operator using the front panel calibration marks.

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Slow Scan TV

For Slow Scan TV (SSTV) operation, set the FREQ control at "TV" and the BW control at "1500/TV". Under normal circumstances, the reduction in bandwidth provided at the "TV" markings should be enough to eliminate most sources of casual interference.

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TABLE 1						
SUGGESTED CONTROL SETTINGS						

MODE	BAND CONDX	FREQ CONT	BW CONT	NOTCH	DYN PEAK	NIR® CONT
CW	Normal, low noise	"CW"	"CW"	Off	Off	Off
CW	Normal, high noise	"CW"	"CW"	Off	On	Off
CW*	EME noise	"CW—"	"CW—"	Off	On	Off
DATA	Normal, low noise	"D"	"D"	Off	Off	Off
DATA	Normal, high noise	"D"	"D"	Off	On	Off
Packet	Normal	"1500+"	"D"	Off	Off/On	Off
SSTV	Typical	"TV"	"TV"	Off	Off	Off
Voice	Normal, low noise	"1500"	"V"	On	Off	Off
Voice	High white noise	"1500"	"V"	On	On	10:00
Voice	High impulse noise	"1500"	"V"	On	Off	10:00 to AUTO
Voice	White & impulse noise	"1500"	"V"	On	On	10:00 to AUTO
Voice	Weak signal in noise	"1500"	"V"	On	Off/On	9:00-10:00
Voice*	Adjacent "chatter"	"1500—"	"V—"	On	Off	Off
Voice*	Chatter plus noise	"1500—"	"V—"	On	Off/On	9:00-10:00 or AUTO

* " A dash (-) after the FREQ and BW control settings means to set the control lower than the suggested marking by one panel mark per dash. For instance, '1500—' means set the control at two marks below the 1500 mark. Likewise, a (+) after the control setting means to set the control higher than the suggested marking by one panel mark per +."

NOTE: Any or ALL modes may be used simultaneously.

OPERATIONAL LIMITATIONS

No physical device is perfect in its operation, and the NIR-12 is no exception. Although JPS Communications has done everything possible to make the NIR-12 as complete a noise reducing device as state-of-the-art allows, there are still limitations of which you, the user, should be aware.

NIR® Mode

First, even with the state-of-the-art techniques used in the NIR-12, it is impossible to completely recover speech when it is heavily corrupted by noise, because some of the information that characterizes the speech is irretrievably lost when covered by the noise. Because of this, use of the NIR® mode at signal to noise ratios below 0 dB may actually reduce intelligibility rather than enhance it. Second, the noise left over after reduction has a strange "electronic" sound. This is not an artifact introduced by the processing as one might think, but rather is all that remains of the original input noise, which because of its random nature, cannot be removed completely. Unfortunately, this residual has been somewhat de-randomized, so that it tends to occur in bursts. Thus, it sounds unnatural and may take some getting used to. The higher the level of noise in the input, the higher the level of this residual in the output. This can often be reduced considerably by energizing the DYN PEAK mode as well. Or it can be masked by reducing the processing level with the NIR® control.

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Dynamic Peak Mode

The DYN PEAK mode may not be effective on some types of impulse noise, such as ignition noise, power line noise, etc. For these noise types, use the NIR® mode or NIR® and DYN PEAK together. The effectivity of the Dynamic Peaking noise reduction may also be degraded if the audio input level from the receiver is too high. Merely reduce the receiver volume and increase the NIR-12 VOL to compensate. The DYN PEAK mode may also be used to reduce or eliminate the electronic artifacts and residual mentioned in the previous NIR® mode paragraph.

TRANSMIT AUDIO PROCESSING

The NIR-12 can be used to process transmit audio. The main advantage is that background noise picked up by your microphone will be removed from your transmitted signal. This may be useful in a vehicle or other high ambient noise environment.

Figure 6 is a diagram of how this might be accomplished. A relay is used to switch the NIR-12 input/output between transmit and receive. During receive, the NIR-12 operates conventionally. In transmit, the NIR-12's input is fed from the amplified microphone source and its output is fed to the transceiver's transmit audio input. The microphone amplifier is required because the unit does not have adequate internal gain to operate on a low level microphone output directly. Some experimentation will be necessary to determine usable operating levels in this configuration.
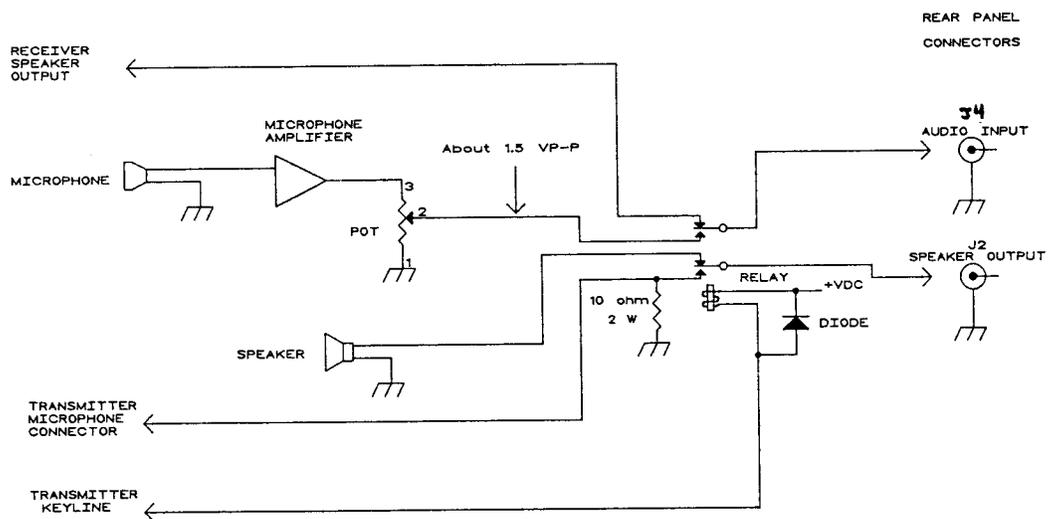
Figure 6 - Connections for Transmit Audio Processing

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SECTION 6

TECHNICAL INFORMATION

SPECIFICATIONS

Audio Input	Unbalanced 22Ω or 47kΩ, internally selectable with jumper. J4 is an RCA-type phono jack.
Frequency Response	200 to 3400 Hz ± 2 dB.
Input Level	120 mVrms to 2.8 Vrms.
Absolute Output Delay	
NIR® Mode	130 milliseconds.
All other modes	< 19 milliseconds.
NIR® Mode White Noise Reduction	
MAX Control Setting	Approx. 20 dB.
MIN Control Setting	0 dB.
DYN PEAK Mode	
White Noise Reduction	Typically 6 to 20 dB.
Peak Factor Switch (S4) Positions	
MIN	Approx. 6 dB noise reduction.
MED	Approx 12 dB noise reduction.
MAX	Approx 20 dB noise reduction.

NOTCH Mode
  Time to Cancel a Suddenly-
    Appearing Tone   About 5 milliseconds (voice modes)
  Ultimate Tone Rejection   Typically greater than 50 dB, one to
                                         four tones. Less for more than four
                                         tones.

BANDPASS
  Bandwidth   Adjustable between 50 Hz and 3400
                                         Hz total width (100 Hz increments
                                         from 100 to 3400 Hz).
  Center Frequency   Adjustable between 200 and 3400
                                         Hz (50 Hz increments).

  Ultimate Out-of-Band
    Attenuation   >60 dB.
  Filter Shape Factor (-60dB/-6dB)   Typically 1.18:1 @ voice
                                         bandwidths.
BYPASS Input J5   Forces BYPASS when pulled down
                                         to +2V or lower.
  Input Impedance $10 k\Omega$, protected to ± 50 V. (RCA
                                         Phono Jack).
HEADPHONE Output J1   For earphones, 8Ω and higher.
                                         (Stereo Phone Jack).
SPEAKER Output J2   2W @ 10% distortion into 8Ω
                                         speaker. (RCA Phono Jack).
LINE Output J3   -18 dBm output nominal into 600Ω
                                         (-12 dBm open circuit). Not affected
                                         by VOL control.

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Audio Output Distortion	Less than 0.5% @ 1 kHz @ 0.5W output.
Input Power Required	+11 to +16 VDC @ 0.6 A Ave., 1 A Peak. Internal Circuits Reverse Polarity Protected.
J6	2.5 mm ID, 5 to 5.5 mm OD coaxial jack, center pin positive.
Size	1.8" H x 7.8" W x 7.2" D (4.6 x 19.8 x 18.3 cm).
Weight	3.8 lbs (1.7kg).
Operating Temperature	-20°C to +55°C.
Storage Temperature	-40°C to +85°C.
Humidity	Up to 95% @ +55°C.

TROUBLESHOOTING

Symptom	Possible Fault
POWER LED does not light	Check AC power source and power line connection. Check for proper seating of the plug in the DC Power Jack J6. Check polarity of the DC power: Unit will not operate if polarity is wrong.
POWER LED is on, but unit does not function and SIGNAL LED does not flash at power-up.	DC Input voltage is too low. Check adapter output voltage under load: it must be a 12 V unit. Less likely: the unit has failed its self-test. Check PROM U28 and both DSP chips U13 and U20 for proper seating in their sockets. Turn unit off, then on again. If fault continues, contact JPS Customer Service.
Unit passes audio, but modes do not respond	Unit is held in BYPASS mode via BYPASS connector J5. Disconnect the input to J5; if problem clears, check your remote signal source for proper polarity and operation. If problem does not clear, contact JPS Customer Service.
SIGNAL LED is on almost continuously	Input audio level is excessive. Reduce the audio input level until the SIGNAL indicator flashes occasionally on strong voice peaks.

TROUBLESHOOTING

| Symptom	Possible Fault
SIGNAL LED flashes at power-up but never lights otherwise	Input audio level is too low for best NIR-12 performance. If you are using receiver LINE output or headphone output for the audio input to the NIR-12, you may have the input impedance jumper set in the LO position. See Section 3, Connections, for instructions.
Audio exists at the PHONES but not at the speaker	Check your speaker and speaker connections. Also check the PHONE plug for an intermittent connection, by plugging a headset in the jack and removing it, several times. If this clears the problem, clean the PHONE connector contacts with alcohol or a contact cleaner. Also clean the headset phone plug, since this is the likely source of the PHONE jack contaminant.
Audio at speaker, but not phones	Check your headphones and connections. If you are using mono phones, see Section 3 regarding the headphone output
CW monitor tone does not pass through the unit	Two possible causes: If the NOTCH filter is on, the tones are being removed, so turn off the NOTCH filter; or your filter center frequency is set at a point different from the frequency generated by your CW monitor. In this case, connect the BYPASS connector J5 to your keyline to disable the NIR-12 when transmitting. See Section 7 for instructions.
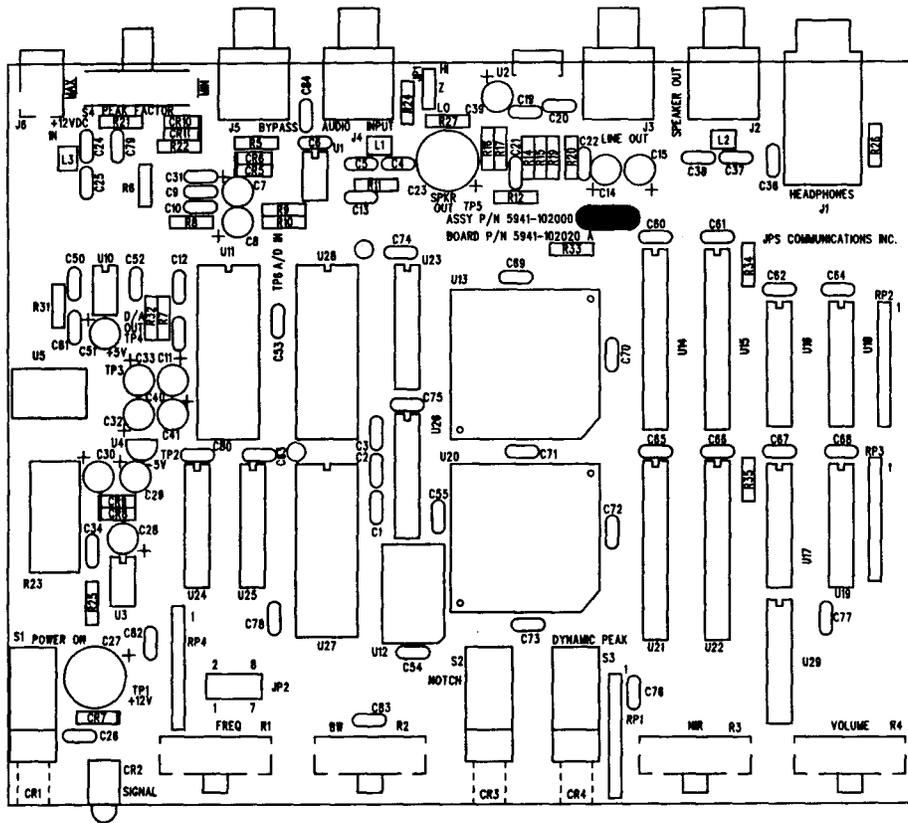
Figure 7 - Printed Circuit Board Parts Placement

SECTION 7

BYPASS CONNECTIONS

This section offers guidance on connecting the NIR-12 BYPASS input to your transmitter or transceiver. You may only need to do this if you experience problems when operating CW, such as receiving a particular tone frequency within a narrow CW bandwidth, while your CW monitor generates a different tone. In this case, you will need to bypass the NIR-12 when transmitting to allow the CW monitor tone frequency to be heard through the unit. Otherwise, the monitor tone frequency will be outside the filter passband and will not be heard.

GENERAL PRINCIPLE

The general principle of the installation is to put the NIR-12 into BYPASS whenever the transmitter is keyed. This will remove all processing to allow the operator to monitor his own transmission through the unit. To do this, the operator must connect the BYPASS connector (J5) [See Figure 2] to a signal from the transmitter that goes low (below +2 VDC) or to ground when the transmitter is keyed.

Most recent commercial transceivers have a remote or accessory connector which contains a signal intended to key a linear amplifier by pulling its keying relay to ground. This signal may have a variety of different names in different equipment from different manufacturers, but the function is all the same. (Consult the transceiver manual for the pin number and the signal characteristics.) This is the signal that will also drive the NIR-12 into BYPASS mode. Use a shielded cable to make this connection for both KEYLINE and GROUND. If the keying signal is already in use in your system, the NIR-12 BYPASS line can also be connected to the same point without ill effects. The NIR-12 BYPASS input impedance is high (10k) so

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that it won't load the transceiver keying output and it will withstand high voltages (up to $\pm$50V) without damage.

If your transceiver does not have a remote connector or remote key output, you can probably connect the NIR-12 BYPASS in parallel with the microphone PTT switch or CW key. Caution: If the transceiver is a tube-type unit, make certain that the keying voltage is positive and less than 50V.

DO NOT CONNECT to the ANTENNA
The BYPASS function is designed to be operated by a DC logic signal only, not by RF. Do not connect the BYPASS to the ANTENNA output of your transceiver. The NIR-12 will be damaged as well as your transmitter output, and the NIR-12 warranty will be voided if this occurs.

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SECTION 8

RS-232 ACCESS TO THE DUAL DSPs

This section briefly describes the RS-232 Interface Option which may be used by DSP software developers to design their own filters, etc. This option is available from JPS and includes a disk with necessary software as well as the interface module described in Figure 8.

The NIR-12 contains an internal header which facilitates the addition of an RS-232 computer interface. With the proper software, this interface may be used to upload software directly to the NIR-12, allowing the user to develop and test DSP algorithms without the need to burn EPROMs. Figure 8 shows the schematic for a simple gain changer necessary to convert RS-232 TTL levels to the proper levels required by the NIR-12. JP1 on the interface should be connected to JP2 in the NIR-12. The RS-232 signals are available on P1. NOTE: Proper use of the RS-232 option requires an understanding of DSP software development and the architecture of the TMS320C26 DSP chip. JPS is not liable for any damage caused to equipment due to improper use or wiring of this interface by the user.

When installed, the RS-232 option supports the serial bootload feature of the TMS320C26. The DSKA assembler and DSKD debugger software supplied by Texas Instruments with their TMS320C26 DSK (and available from a number of bulletin boards and Internet sites) can be used to develop and debug software on the NIR-12.

In order to use the serial port interface on the NIR-12, it is necessary to remove the PROM (U28) from its socket. If the bootloader on the TMS320C26 detects the presence of the PROM, it will not activate the serial bootloader, and serial communication with the NIR-12 cannot take place.

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Anyone wishing to develop software using the NIR-12 as a development platform is encouraged to obtain a copy of the "TMS320C2X User's Guide" available from Texas Instruments.

A complete package consisting of the RS-232 adapter and development software is available from JPS. Please call or write for pricing and availability.

Figure 8 - Level Changer Schematic for RS-232

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SECTION 9

**TECHNICAL
DESCRIPTIONS**

</div>

AUDIO SECTION

The audio circuitry is detailed in Figure 9. The diagram is a full schematic of the audio and power supply sections and includes all circuitry which is not DSP hardware. The full schematic is given here because we consider it possible to troubleshoot these sections of the circuitry in the field.

AUDIO INPUT

Audio input at connector J4 is routed to op-amp U1A, a unity gain buffer amplifier. Resistors R5 and R6, along with diodes CR5 and CR6, protect U1A against input overloads.

AUDIO OUTPUT

The processed audio signal from the DSP circuitry is fed to a passive twin-T filter comprised of R7-R9 and C9-C12. This filter attenuates any quantization or data bus noise from the D/A converter. The output of the twin-T filter is fed to the VOLUME control R4 and also to J3, the LINE OUTPUT jack. The wiper of the VOLUME control is supplied to U2, the speaker driver amplifier. The output of this amplifier is routed to the SPEAKER OUTPUT connector, J2, via the HEADPHONE jack, J1. Whenever headphones are plugged into J1, the audio output from J2 is disabled.

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POWER

The DC power supplied through J6 is filtered by L3 and C24, C25 to prevent rf interference out of or into the unit via the power cable. Power is switched to the unit by S1. CR7 provides reverse polarity protection. U3 is configured as an oscillator whose output is rectified, the resultant DC voltage doubled and filtered, then is regulated to provide the -5VDC source. Regulation of the +5VDC from the +12VDC source voltage is provided by U5, and series dropping resistor R23 limits the regulator's power dissipation to keep it within acceptable levels.

MISCELLANEOUS

The REMOTE BYPASS jack J5 is interfaced to the DSP digital input through diodes CR10 and CR11 and resistor R21. These components protect the digital circuitry from non-TTL input levels and provide the proper polarity for the BYPASS function when nothing is connected to J5.

DSP and DIGITAL SECTION
(See Figure 10)

The general purpose of the DSP and digital section is to convert analog signals into a digital format, where they are operated on and manipulated by the digital signal processor, then the result converted back into an analog format. The NIR-12 incorporates two Digital Signal Processors for improved performance and expandability. The primary tasks of the NIR-12 (noise and interference reduction and bandpass filtering) are performed by this section.

The DSP and digital section of the NIR-12 is shown in schematic Figure 10. Although this section is probably not serviceable in the field, the entire schematic diagram is presented here.
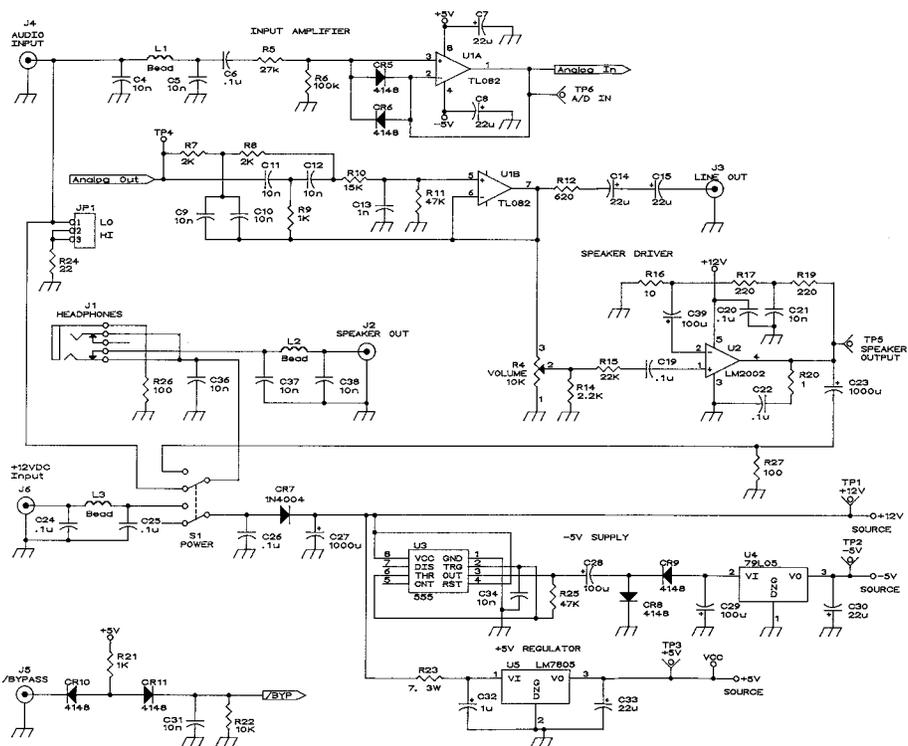
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Figure 9 - Audio and Power Supply Section Schematic

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MASTER DSP AND AIC

U13 is a 40 MHz TMS320C26 digital signal processor. This device is designated as the Master DSP, and handles all user input functions, NOTCH filter, Dynamic Peaking noise reduction and the tunable bandpass filters. The software for this DSP is contained in PROM U28. When power is applied to the NIR-12, the operational software is loaded from the PROM into high speed Random Access Memory (RAM). Ics U14 and U15 provide RAM expansion for U13. Memory decode and other control signals are provided by programmable logic devices U23 and U26. User input is handled by U24, a parallel input port which reads the switches, and U27, an A/D converter which reads the voltages on the FREQ, BW and NIR® level controls. The LED indicators are driven by U25, a parallel output port. The Master DSP (U13) interfaces with U11, an Analog Interface Circuit (AIC), which contains 14 bit Analog-to-Digital (A/D) and Digital-to-Analog) D/A converters.

SLAVE DSP

U20 is a 40 MHz DSP, identical to the Master DSP U13. However, unlike U13, U20 has no PROM and must have data loaded via the 16 bit parallel mailbox made up by U16-U19. RAM expansion for U20 is provided by U21 and U22, The decoding and control signal generation is provided by programmable logic device U29.

MISCELLANEOUS

U10 is a voltage supervisor/reset generator which ensures an orderly power-up sequence for the Master DSP and associated components. It senses the voltage on the +5VDC line and generates a reset whenever the voltage drops below approximately 4.55V. As the voltage rises above the threshold, a delay is generated to ensure processor clock stability before operation can commence.

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JP2 provides access to the control lines used by the Master processor's serial bootloader. This allows connection of an RS-232 interface so that user-generated software can be loaded into the NIR-12 and debugged using a PC. For more information, see Section 8 of this manual and also the instructions furnished with the NIR-12 Software Developer's Kit.

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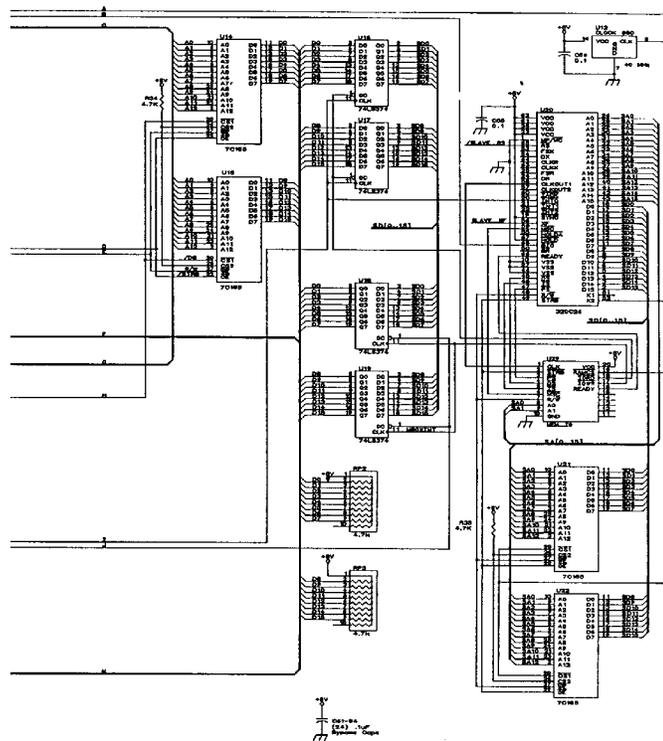
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Figure 10 - DSP and Digital Section Schematic (Part 1)

Figure 10 - DSP and Digital Section Schematic (Part 2)

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