

NHRC

REPEATER CONTROLLERS

NHRC-5

User Guide

Software Version: 1.03

User Guide Version: 2003-Feb-15

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Thank You!

Thank you for purchasing the NHRC-5 Repeater Controller. This controller has been designed using the very latest state-of-the-art technology. Please review this manual carefully before putting your controller into operation.

This manual represents a very large documentation effort. Your comments are important to us. If you find an error or find any passages that are not clearly understandable, we would like to hear about it. Please send your comments to ***software-support@nhrc.net***.

Support for the controller is available by email or telephone. Please direct software-related questions via email to ***software-support@nhrc.net***. Please direct hardware-related questions via email to ***hardware-support@nhrc.net***. Your question(s) will be answered promptly.

Questions of a more urgent nature can be answered by telephone support. Telephone support is available Monday through Friday, from 6 PM until 10 PM, Eastern time.

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1. Introduction

The NHRC-5 Repeater Controller represents the current state-of-the-art in repeater controller designs. It utilizes the latest available technology to provide maximum functionality with the lowest number of parts. This results in very reliable operation.

The key features of the NHRC-5 are:

- Recording of two real speech ID messages, one real speech time-out message, and one real speech tail message.
- Local language support using a custom recording capability.
- Simplex repeater mode.
- Remote base/link port.
- Control receiver input.
- Auxiliary audio input.
- Unique courtesy tones to indicate status of link port or digital input ports.
- 4 digital outputs.
- Transmitter fan control output automatically runs fan while transmitting and for a programmable delay after.
- DTMF, “Carrier,” “Carrier and CTCSS,” and “Carrier or CTCSS” access modes.
- Granular security features that allow tailored control operator access.

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1.1 Sending commands

All of the controller's commands are sent by DTMF (Touch-Tone®) sequences that are received on the main repeater. DTMF tones received will be evaluated, and if correct, executed, when either the DTMF inter-digit timer expires (2.0 seconds) or the CAS (receiver unsquelched) signal drops; whichever comes first. This allows the controller to be commanded even when a weak on-channel signal is holding the receiver's squelch open.

To send a command over the main repeater,

1. Key your transmitter.
2. Enter the DTMF command digits.
3. Unkey the transmitter.

This will cause the command to be evaluated immediately.

If you pause for more than 2.0 seconds while sending a command, the command you entered prior to the pause will be evaluated, the command buffer will be emptied, and you can immediately enter another command.

When a command is successfully evaluated, the controller will send a response. Each command's possible responses are detailed with the command description.

In general, if you do not receive a command response, then the controller did not accept your command.

1.2 ID Messages

The controller supports two voice ID messages and one CW ID.

The voice messages are comprised of:

- an "initial" ID message, that plays when the controller has been idle for a period longer than the ID timer, and
- two "normal" ID messages, that play during repeater use. The controller will alternate between these two ID messages.

The initial and both of the normal ID messages together can be enabled or disabled. The CW ID will play when a voice ID message is required but disabled. The CW ID will also play if the ID timer expires during a user's transmission. The controller tries to be "polite" when identifying; if it is almost time to ID when a user unkeys, the ID is sent immediately.

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1.3 “Unlocked Mode”

All of the controller’s important programming information is protected by a special password, the “unlock code.”

Programming the unlock code requires physical access to the controller to place a jumper on the circuit board.

The unlock code cannot be programmed without physical access to the controller.

When the unlock code is successfully entered into the controller, the controller will transmit “OK” in CW, and a special courtesy tone will be used to indicate the controller is unlocked.

The controller can be locked by:

- sending the “#” command, or
- the controller will lock itself after two minutes of inactivity.

When the controller leaves the unlocked mode:

- the courtesy tone will revert to the normal tone for the controller’s current state.

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2. Electrical Connections

This section of the User Guide describes the electrical interfaces used to connect the controller to:

- power
- repeater and link radios
- the control receiver
- auxiliary audio
- NHRC-DAD digital audio delay boards
- Digital outputs
- Digital Inputs

It is intended for the repeater operator to use in the planning and installation of the NHRC-5 Repeater Controller into a repeater system.

2.1 Input and Output Signal Levels.

Control signals into the NHRC-5 are active-high signals. The repeater activity inputs (CAS and CTCSS Decode) are buffered in the controller to allow the connection of popular radios to the controller. Signal levels should be 0.0 to 0.5 volts for off, and 2.0 to 16.0 volts for on. Expansion port signal levels are TTL compatible.

The controller's PTT and FAN CONTROL outputs are "open-drain" connections to power MOSFETs. These outputs are active-low, and when activated, will pull the control signals to within a few ohms of ground. These outputs can sink 100 mA or so. NHRC recommends that diodes be used to protect the MOSFETs from back-EMF if these signals are used to drive relays.

Audio signals into the controller should be in the range of 0.2 to 2.0 volts peak-to-peak. The controller's transmit audio outputs are adjustable from about 0.1 volt to about 5 volts peak-to-peak.

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2.2 DC Power Connector

A mating power connector is supplied with the controller.

DC Power is supplied to the controller at connector “J3 12V,” with a 5.5 mm coaxial power connector.



5.5 mm Coaxial Power plug

The inner connector (“Tip”) is positive

The outer barrel (“Sleeve”) is negative.

⇒ **Caution:** Reverse polarity could damage the controller, and will probably blow the controller’s fuse.

J3 12V Connector Pin-out

	Pin #	Use
Sleeve	“Outer Barrel”	Ground
Tip	“Inner Connector”	+12 (13.8)

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2.3 Repeater Connector

The main repeater is connected to the controller through the “J1 REPEATER” connector.

J1 is a Female DB9 Connector.

A Male DB9 Connector is included with the controller.



Male DB-9 Connector

J1 REPEATER Connector Pin-out

Pin #	Use	Comments
1	Ground	
2	CTCSS Decode	Active High
3	PTT	Active Low
4	Transmit Audio	From Controller
5	Receiver Audio	To Controller
6	No connection	reserved
7	CAS	Active High
8	Ground	
9	Fan Control	Active Low

2.3.1 Use of the Fan Control Digital Output

The NHRC-5 has a digital output that is intended to control a fan on the repeater’s transmitter. This output will be activated (the output MOSFET will close the pin to ground) when the transmitter is on and for a programmable amount of time after the transmitter shuts off. See section 3.6.1 for information on programming the fan timer.

The digital output can be configured to be under control operator control, and not used as the fan timer. Control operator group 2 switch 4 can disable the automatic fan control, and control operator group2 switch 5 can then be used to turn the output on of off. See section 4.3 for more information on these switches.

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2.4 Link/Remote Base Connector

The link/remote base radio(s) is connected to the controller through the “J2 REMOTE BASE” connector.

J2 is a Female DB9 Connector.

A Male DB9 Connector is included with the controller.



Male DB-9 Connector

J2 REMOTE BASE Connector Pin-out

Pin #	Use	Comments
1	Ground	
2	CTCSS Decode	Active High
3	PTT	Active Low
4	Transmit Audio	From Controller
5	Receiver Audio	To Controller
6	No connection	
7	CAS	Active High
8	Ground	
9	Ground	

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2.5 Control Receiver Connector

The control receiver, if present, is connected to the “J5 CTRL RX” jack. J5 is a 3.5 mm monophonic mini-phone jack.



3.5 mm mini-phone plug

If the control receiver is plugged in, then the control receiver/remote base DTMF decoder will receive the control receiver audio rather than the remote base audio.

If the control receiver is not plugged in, then the control receiver/remote base DTMF decoder will receive the remote base audio.

⇒ **Note:** Consult section 4.2 for information about the link port control receiver mode switch which may need to be set depending upon your control receiver choice.

J5 CTRL RX Connector Pin-out

Pin #	Use
Sleeve	Ground
Tip	Control Receiver Audio

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2.6 Auxiliary Audio Input Connector

The NHRC-5 supports an auxiliary audio input. This input can be used for applications like NOAA weather radio receiver, site microphone, etc. The auxiliary audio input can be automatically or manually controlled. The source of auxiliary audio is connected to the “J4 AUX AUDIO” jack. J4 is a 3.5 mm monophonic mini-phone jack.



3.5 mm mini-phone plug

⇒ **Note:** Audio signal conditioning and level control is not provided for the Auxiliary Audio input. Signal conditioning and level control must be supplied by the user.

⇒ **Note:** Consult section 4.5 for information about automatic control of the auxiliary audio input.

J4 AUX AUDIO Connector Pin-out

Pin #	Use
Sleeve	Ground
Tip	Control Receiver Audio

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2.7 Delay Connectors

The NHRC-5 supports the NHRC-DAD, a CODEC digital audio delay, to reduce squelch crashes and fully mute DTMF tones.

Jacks “J8 MAIN DELAY” and “J7 RB DELAY” are provided on the controller to interface NHRC-DADs.

Jacks J8 and J7 are .100” pin headers.

Note that if the DAD is not used, a shorting jumper must be installed between pins 2 and 3 of each of these jacks otherwise the controller will not pass audio.

J8 MAIN DELAY and J9 RB DELAY Connector Pin-out

Pin #	Use
1	+12
2	Audio to DAD
3	Audio from DAD
4	Ground

See Section 4.3 for information about enabling a connected DAD.

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2.8 J6: Digital I/O Expansion Connector

Warning: Failure to read and follow the instructions below could result in severe damage to your controller. Damage to the controller caused by improper use of the expansion port is not covered under warranty by NHRC.

The NHRC-5 has an expansion connector to allow users to interface custom hardware to the controller. The expansion connector has unbuffered microcontroller port signals which must be conditioned to safely interface the controller to external devices. Signals at improper levels can cause the destruction of the port pins, microcontroller, or destroy the repeater controller itself. Your use of this interface is completely at your own risk, and is not supported by NHRC.

J6 DIGITAL IO Expansion Connector

Pin	Signal	Description
1	+5 Volts	Regulated +5 Volts
2	EXP1	CAS\ for Auxiliary Audio Input
3	EXP2	ALARM\ for alarm telemetry
4	EXP3	Courtesy Tone Select Input 1
5	EXP4	Courtesy Tone Select Input 2
6	EXP5	Digital Control Output 1
7	EXP6	Digital Control Output 2
8	EXP7	Digital Control Output 3
9	EXP8	Digital Control Output 4
10	Ground	Ground

2.8.1 CAS For Auxiliary Audio.

Input EXP1 serves as a CAS input for the auxiliary audio input. This input is active low, and should be pulled to ground by the external device to indicate that audio is present on the Auxiliary Audio Input. When the Auxiliary Audio Input is set for “automatic” mode, a low present on this signal will result in the Auxiliary Audio being transmitted over the controller.

NHRC recommends that an external pullup resistor of 10K ohms be used to pull this input to +5 volts when any external logic is attached.

2.8.2 ALARM\ Alarm Indicator

Input EXP2 serves as an alarm indicator. This input is active low, and should be pulled to ground by an external device to indicate a site alarm function. Once the alarm is tripped, an alert tone will play over the repeater’s transmitter every 5 minutes, until the alarm is reset. See section 4.5 for instructions to enable the alarm, and section 5.5.1 for the alarm clear command.

NHRC recommends that an external pullup resistor of 10K ohms be used to pull this input to +5 volts when any external logic is attached.

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2.8.3 Courtesy Tone Selection

Inputs EXP3 and EXP4 can be used to select alternate courtesy tones to indicate alarm status, voted receiver status, etc. These pins are configured as inputs to the microcontroller, and have an internal weak pullup resistor to set the state of the pins when they are not connected. NHRC recommends that an external pullup resistor of 10K ohms be used to pull these inputs to +5 volts. When the inputs are pulled to ground, different courtesy tones are selected, as shown below:

Courtesy Tone Selection

EXP3	EXP4	Courtesy Tone Selected
High	High	Controller's Normal Courtesy Tone
Low	High	Courtesy Tone 6
High	Low	Courtesy Tone 7
Low	Low	Courtesy Tone 7

2.8.4 Digital Output Ports

Outputs EXP5, EXP6, EXP7, and EXP8 are active high outputs, that are used as digital outputs 1 through 4. These pins can sink or source a maximum current of 20 mA, however NHRC recommends a maximum of 5 mA in or out of these pins. These outputs must be buffered through power transistors, FETs, or solid-state relays. The state of these digital outputs can be stored in a saved setup.

2.8.4.1 CTCSS Encoder Control

Outputs EXP5 and EXP6 can be used to control the main and link transmitters CTCSS encoders, respectively. These outputs will provide an active-high signal when the CTCSS encoder should generate tone. NHRC suggests the use of a NPN switching transistor (such as a 2N2222 or 2N3904) in an open-collector configuration to control most popular CTCSS encoders, such as the TS-64, which require an active-low signal to encode tone.

The controller can be configured to cause tone to be encoded only when an input is active, or until 200 milliseconds before the transmitter shuts off, which can mute the user's receiver and reduce or eliminate squelch crashes in the user's radio.

See section 4.6 for information on the CTCSS encoder control settings.

2.8.5 Power and Ground connectors

Pin 1 provided regulated 5 volts for your interface circuitry, i.e. to provide +5 VDC to the pullup resistors used for the courtesy tone selection inputs. This power source should not be used to power external loads under any circumstances.

Pin 10 provides a ground return for your external expansion logic circuits. This ground source should not be used as the return for any external loads controlled by the controller.

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2.9 Audio Level Adjustment

Description of Audio Processing:

The NHRC-5 uses analog switching and audio mixing to route audio from audio sources to the transmitter port and voice recorder.

The controller's audio path is described in detail below.

The main receiver's audio is passed into the controller through potentiometer VR6, and then buffered through audio amplifier U1A for impedance isolation and equalization. This amplifier can be set up to provide flat audio response or 6 dB/octave de-emphasis with a roll-off of approximately 250 Hz, allowing the use of discriminator audio. The buffered audio is then passed to touch-tone decoder U6, and through connector J8 to the *optional* digital audio delay board for squelch tail elimination. If the digital audio delay is not present, J8 pins 2 and 3 must be jumpered to allow audio to continue to pass through the controller. After the digital audio delay connector, the main receiver audio is gated through analog switch U2A. The gated audio is supplied to the transmitter mix bus via potentiometer VR8, and into the digital voice recorder (DVR) chip via potentiometer VR7.

The remote base receiver's audio is passed into the controller through potentiometer VR1, and then buffered and equalized through audio amplifier U1D, identically to the main receiver audio. The buffered audio is presented to J7 for the remote base receiver's *optional* digital audio delay board. If the digital audio delay is not present, J4 pins 2 and 3 must be jumpered to allow audio to continue to pass through the controller. Remote base audio is gated through analog switch U2B, directly onto the transmitter mix bus.

Flat or de-emphasized audio on the main and remote base ports is simply selected by moving the shorting jumpers from (N) normal position to (D) de-emphasized position. Note: If the jumper is completely removed, the audio processing circuit will provide approximately a 10X audio gain with flat response.

Courtesy tones are generated by the microcontroller IC U8, filtered through R1 and C2, and provided to the transmitter mix bus through potentiometer VR3.

DVR output is provided to the transmitter mix bus via potentiometer VR2.

Auxiliary audio is buffered through audio amplifier U1C, and gated through analog switch U2D directly into the transmitter audio mix bus.

The transmitter mix bus is provided to the main transmitter through buffer amplifier U2A, with its level adjusted with potentiometer VR9. The transmitter mix bus is also provided to the remote base transmitter through buffer amplifier U2B with its level adjusted with potentiometer VR4.

Description of Controls:

VR6 sets the receiver audio input level into the controller, and, more critically, into the DTMF decoder.

VR1 sets the link/remote base audio level into the transmitter mix bus.

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VR7 sets the receiver audio level into the ISD voice recorder IC.

VR8 sets the receiver audio level into the transmitter mix bus.

VR2 sets the recorded speech level into the transmitter mix bus.

VR3 sets the beep level into the transmitter mix bus.

VR9 sets the transmit audio master level.

VR4 sets the link/remote base transmit audio master level.

VR5 sets the control receiver DTMF decoder input level.

Audio Level Setup:

Recommended equipment:

- Signal generator or other method of generating a RF signal for the main receiver, modulated with a 1 KHz tone at 3 KHz deviation.
- A deviation meter.
- A Service Monitor is recommended for overall ease of alignment.

Procedure:

The reference level will be a 1 KHz tone at 3 KHz deviation

1. Prepare the controller for audio alignment by setting all potentiometers to the midrange position and properly configuring the input equalization (normal or de-emphasized) by setting jumper JP2 to the appropriate pins.
2. Transmit the reference tone through the repeater and adjust VR6 for reasonable transmitted deviation, about 3 KHz. The final adjustment of VR6 will occur later. Turn off the reference signal.
3. Transmit some DTMF tones into the repeater, and adjust VR6 for reliable DTMF decoding, as indicated by LED D5.
4. Use VR8 to set the received audio repeat level.
5. Use VR3 to set the courtesy tone to a reasonable level.
6. Unlock the controller and force it to transmit the recorded voice ID with the *800 command. Set the DVR playback level with VR2. Lock the controller.
7. Set the DVR input level. This is best set by setting the controller into simplex mode, recording a test message and allowing it to play back. Adjust the input level so that the test message is played back at the same level as it originally passed through the repeater. Overdriving the DVR will result in compression of recorded audio,

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complete with “noise pumping” effects, so it is important that the level is not set too high. Use VR7 to set the DVR’s input level.

8. *Hint:* With the controller in duplex mode (not simplex) set up your signal generator with the test tone. Note the deviation of the *repeater’s* transmitted signal. Shut off the generator. Now set the controller into simplex mode and send the test tone for 15 or 20 seconds, then turn off the test tone. The DVR will now play back the recorded test tone. Note the deviation. Repeat this test and adjust the DVR input until the record and playback deviation is the same. ***Be careful*** to remember to subtract out your CTCSS deviation to get a true DVR deviation measurement.
9. Turn on the remote base. Send the test tone on the remote base Rx frequency. Set the incoming level to be similar to other levels on the audio bus by adjusting potentiometer VR1.
10. Transmit a test tone into the repeater and set the remote base transmit deviation with potentiometer VR4.
11. If necessary, the output level of the controller can be adjusted with VR9.
12. The control receiver audio enters the controller at jack J5, unless nothing is plugged into J5, in which case, the controller will use the remote base receiver audio as the control receiver. In either case, potentiometer VR5 adjusts the control receiver audio level into DTMF decoder U4. VR5 should be adjusted so that received DTMF tones are reliably detected as indicated by LED D10.

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2.10 The LED Indicators

The NHRC-5 has nine LED indicators. These LEDs indicate the state of various inputs and outputs of the controller. The LEDs are particularly useful during setup. The LEDs display the following information:

NHRC-5 LED Indicator Functions

LABEL	COLOR	USE
+12V	Red	Power Indicator
PTT	Red	Main Repeater Transmit
COR	Green	Main Repeater Unsilenced
PL	Green	Main Repeater CTCSS Detect
RB PTT	Red	Link/Remote Base Transmit
RB COR	Green	Link/Remote Base Unsilenced
RB PL	Green	Link/Remote Base CTCSS Detect
DTMF0	Yellow	Main Repeater DTMF Detect
DTMF1	Yellow	Link/Remote Base or Control Receiver DTMF Detect

All LEDs, except the +12V LED, can be disabled to reduce power consumption by removing jumper JP3.

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3. Programming the Controller

This section of the User Guide describes how the repeater operator programs the repeater.

It is intended for repeater operators and users who have an interest in how the controller is customized for specific configurations.

⇒ **Note:** *n commands are only available when the controller has been unlocked by sending the unlock command.

3.1 Quick Start

This section of the User Guide is intended to get a first-time user “up and running” quickly using a minimum of the customizable features.

Procedure:

- **Make all the necessary electrical connections.** See Section 2.
- **Install the initialize jumper** (JP4, located adjacent to LED D10.)
- **Apply power to the NHRC-5.** After a short pause, the controller will transmit “NHRC 5” in CW. At this time, NHRC recommends that you immediately program the unlock code.
- **Leave the initialize jumper installed** for this operation.
- **Send the default unlock code (07) to the controller.** The controller should respond with a CW “OK.”
- **Use the *2 command to program command prefix 07: the unlock prefix.** To program the unlock code to 314159, send the following command: *207314159. The controller will send “OK” in CW when the unlock code is accepted.
- **Send the “#” command to lock the controller.** The controller should respond “control access disabled.”
- **Remove the initialize jumper** (JP4, located adjacent LED D10.)

You should record the voice ID messages (#0, 1, 2), the time-out message (#3), the tail message (#4) and program the CW ID at this time. See Sections 3.10.1 and 3.11.2 for information on programming the CW ID and recording voice messages.

This is a good time to program all the command prefixes. See Section 3.5 for information on programming command prefixes.

⇒ **Note:** NHRC strongly recommends that you do not leave the initial default command prefixes in the controller.

3.2 *Initializing the Controller*

Initializing the controller will re-program the controller's non-volatile EEPROM memory with the factory defaults. All customized settings are lost, including command prefixes, timer presets, the CW ID, and the voice messages are reset.

⇒ **Note:** The controller should never require initialization except for new installations.

Procedure:

- **Install the initialize jumper** (JP4, located adjacent to LED D10.)
- **Apply power to the controller.** After a short delay of about 10 seconds, the controller will sent the CW message "NHRC 5".
- **Remove the initialize jumper** (otherwise the controller will initialize again the next time it is powered up).

⇒ **Caution:** DO NOT LEAVE THE INITIALIZE JUMPER INSTALLED.

See the Appendix for factory defaults for the controller.

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3.3 *0: Unlocked Mode Control Operator Access

3.3.1 Set Control Operator Switches

The *0 command allows access to control operator switch groups while the controller is unlocked. In addition to that, this command allows access to groups 8 and 9 which are not accessible using the control operator prefix. These groups help to implement controller security by controlling write access to controller data and control operator access to the other 8 groups.

The format of this command is

***0**<g><i><s> where:

<g> specifies the group number. Valid range is 0 to 9.

<i> specifies the switch number. Valid range is 0 to 7.

<s> is optional. If present, it is the new state of the switch. Valid values are 0 and 1.

Upon receipt of a valid *0 command without the state, the controller will transmit the current state of the selected control operator switch.

Example: Sending the command *000 will inquire of the state of control operator group 0 item 0, and the controller will read back the current state: either “ON” or “OFF” in CW.

See Section 4 for more information about control operator switches.

3.4 *1: Save Setup

The NHRC-5 Repeater Controller has two “saved configuration setups” that allow the repeater operator to save two presets of all 80 of the control operator switches.

The default setup is #0 which is loaded when the controller is powered up.

3.4.1 Save configuration setup

*1<n> where:

<n> specifies the setup number to save. Valid range is 0 or 1.

After a valid command is received, the controller will respond with “OK” in CW.

A saved setup can be loaded by using the load saved setup command:

See Section 5.3 for information about the Load Saved Setup command.

<p>Example: To save the current controller state (all 10 control operator switch groups) as state #1, send the following command with the controller unlocked: “*11”. The controller will transmit "OK" in CW if the command is accepted.</p>
--

3.5 *2: Program Command Prefixes

Every command accepted by the NHRC-5 controller when it is locked consists of a command prefix and optional command arguments.

Each prefix can be programmed to restrict access to certain functions to only those users who know the prefix. This gives the repeater operator the ability to only allow certain users to access certain features.

Command Prefix Rules:

- A command prefix is one to seven digits long.
- A command prefix cannot be left blank.
- No two command prefixes should be programmed the same or be programmed the same as the beginning of a different prefix. For example, do not program the control operator prefix to 1234 and the digital output control prefix to 12345, because the controller would not understand whether 123456 was intended to set control operator switches or change the state of the digital outputs.

Section 6.1.1 describes the Factory Default Command Prefixes.

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3.5.1 Set command prefix

*2<pp><prefix> where:

<pp> specifies the prefix number to set. Valid values are in the range 00 to 15. Two digits must be used. See the Command “Prefixes by Number Table” to determine the prefix number you want to set.

<prefix> specifies the new prefix to assign. Must be 1 to 7 digits in length. Valid digits are 0-9, A-D, * and #.

After a valid command is received, the controller will respond with “OK” in CW.

This table shows the prefix number and default prefix value for each command. The default prefixes are set when the controller is initialized, and are overwritten when the prefix is programmed with a new value.

Command Prefixes by Number

<u>Prefix Number</u>	<u>Default Prefix</u>	<u>Description</u>
00	00	Control Operator
01	01	DTMF Access
02	02	Digital Output Control
03	03	Load Saved Setup
04	04	Remote Base
05	05	Auxiliary Audio Input Control
06	06	Audio Test
07	07	Unlock Controller

Example: To set the DTMF access prefix to 4321, send the following command with the controller unlocked: “*2014321”. The controller will respond with a CW “OK” if the command is accepted.

⇒ **Note:** For security reasons, *command prefix 7 (the unlock code) cannot be changed unless the initialize jumper (JP4) is installed*. This means that the unlock code cannot be changed without physical access to the controller. To change the code, install the jumper, enter the command, and remove the jumper. Do not leave the initialize jumper installed, and do not power up the controller with the initialize jumper installed, unless you want to reset the controller to factory defaults.

⇒ **Caution:** Do not set any prefix to use the same initial digits as any other prefix, because the controller will not be able to tell the difference between them. For example, if the DTMF access code is set to “123”, and the load saved setup code is set to “1234”, then when a user sends “1234123456” the controller will try to load saved setup 123456, rather than correctly enabling the controller.

3.6 *3: Set timers

The NHRC-5 has 8 “timers,” one of which is not really a timer, but is an event counter.

Each timer has its own resolution which is the amount of time each timer count represents.

For example, the hang timer’s resolution is .1 second. To program a hang time of 5.0 seconds, the hang timer would actually be programmed to 50 because there are 50 .1 second intervals in 5.0 seconds.

The tail message counter is used to play the tail messages every n^{th} time the tail timer expires.

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3.6.1 Program a timer

The NHRC-5 timers are programmed as follows:

*3<nn><time> where:

<nn> specifies the timer to set. Valid range is 00 to 12. Both digits must be present. Consult the table below to determine the number of the timer you want to change.

<time> The value to program the timer to. The valid range for <time> is 0 to 255

After a valid set timer command is received, the controller will respond with "OK" in CW.

NHRC-5 Timers, by Number

<u>Timer No.</u>	<u>Description</u>	<u>Timer Resolution</u>	<u>Default Value</u>
00	Hang Timer Long	.1	10.0 seconds
01	Hang Timer Short	.1	5.0 seconds
02	ID Timer	10	540 seconds (9 minutes)
03	DTMF Access Timer	10	600 seconds (10 minutes)
04	Time-out Timer Long	1	180 seconds
05	Time-out Timer Short	1	30 seconds
06	Fan Timer	10	120 seconds
07	Alarm Alert Timer	10	60 seconds
08	Tail Message Counter	1	0 tail drops

Examples:

To program the ID timer to 6 minutes (480 seconds), send the following command with the controller unlocked: "*30248". If the command is accepted, the controller will respond with "OK" in CW.

To set the long hang timer for 20 seconds, send the following command with the controller unlocked: "*300200". If the command is accepted, the controller will respond with "OK" in CW.

⇒ **Note:** The short hang timer, and the long time-out timer are selected by the controller's initial defaults. Consult section 4.1 for instructions on selecting the long hang timer, and section 4.2 for instructions on selecting the short time-out timer..

3.7 *4: (*Reserved for NHRC*)

This command is reserved by NHRC for future expansion.

3.8 *5: (*Reserved for NHRC*)

This command is reserved by NHRC for future expansion.

3.9 *6: (*Reserved for NHRC*)

This command is reserved by NHRC for future expansion.

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3.10 *7: Program CW and Beep Messages

The *7 command is used to program or play the CW ID and courtesy tones.

3.10.1 Program the CW ID

The CW ID can be programmed or played with the *70 command, as follows.

***70<dd..dd..dd..>** where:

<dd..dd..dd..> is the CW ID message. If left blank, the current CW ID message will play. When present, the part of the command represented by **<dd..dd..dd..>** consists of 1 to 12 digit pairs. Each pair of digits represents one CW character.

See Section 6.1.4, the CW Character Table, to look up the code for each CW character.

Example: To program “DE N1KDO/R” as the CW ID, the following command would be entered: *70 31 32 11 62 01 52 63 12 72.

To play the CW ID, the following command would be entered: *70

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3.10.2 Program or Play Courtesy Tones

The NHRC-5 supports eight different courtesy tones. Courtesy tones are composed of up to four segments of tones. Each segment has a tone frequency and duration.

The courtesy tone is selected based upon the logic levels present at expansion connectors EXP0 and EXP1. If no signals are connected to these pins, then courtesy tone 3 is used. Consult section 2.8 for information on the electrical interfacing to the expansion connectors.

The courtesy tones are played and programmed with command *71 as follows:

***71<n><ddtt ddtt ddtt ddtt>** where:

<n> is the courtesy tone number to play or program. The valid range of values is 0 to 7.

<ddtt ddtt ddtt ddtt> is up to four sets of duration and tone.

Duration is in 10 ms increments, valid range is 01-98. Both digits must be specified. Tone is the number of the tone from Section 6.1.3, the Courtesy Tone Component Tones Table.

Example: The default courtesy tone #0, (four 50MS bursts of notes E5, G5, B5, D6) would be programmed like: *7100517052005240527.

Courtesy Tone Uses

<u>Tone</u>	<u>Use</u>
0	Main receiver courtesy tone.
1	Main receiver courtesy tone, link alert mode, link receiver active
2	Main courtesy tone, link transmit enabled
3	Link receiver courtesy tone, link transmit disabled.
4	Link receiver courtesy tone, link transmit enabled.
5	EXP3 low courtesy tone
6	EXP4 low courtesy tone
7	Controller unlocked courtesy tone

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3.10.3 Voice Message Courtesy Tone

Any courtesy tone can be programmed to play stored voice track 4 (the tail message/courtesy tone track) by programming the courtesy tone to 0000.

Example: To program the default courtesy tone (#0) to play the tail message/courtesy tone track, send *71 0 0000.

3.10.4 CW Letter Courtesy Tone

Any courtesy tone can be programmed to play any CW letter. The courtesy tone should be recorded as 99xx, where xx is the CW character code from table 6.1.4.

Example: To program courtesy tone #4 (the link transmit enabled courtesy tone) to play the CW letter “L”, send *71 4 9953.

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3.11 *8: Play/Record Voice Tracks

The NHRC-5 supports eight stored voice messages. The repeater operator will want to customize some or all of these messages. The *8 command allows the repeater operator to record their preferred voice messages.

The controller's speech IDs, tail message, time-out message, etc. should all be recorded by the repeater operator.

3.11.1 Play a message

Command *80 is used to play messages:

***80<n>** where:

<n> is the message to be played. Valid range for <n> is 0 – 122.

Example: To play back the initial ID message (message #0), send the following command with the controller unlocked: "*800". The controller will play back the initial ID message.

NHRC-5 Stored Speech Messages

Message Number	Usage
0	Initial ID message
1	Normal ID message 1
2	Normal ID message 2
3	Time-out message
4	Tail message/courtesy tone
5	Link Off message
6	Link On message
7	Audio Test message

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3.11.2 Record a message

Command *81 is used to record messages.

***81<n>** where:

<n> is the message to be recorded. Valid range for <n> is 0 – 7.

To record a message, enter *81, followed by the message number you want to record. The controller will prompt you sending “OK” in CW. After the prompt, key your radio and speak clearly to record the message. The recording is terminated when either you stop transmitting or the message slot is full (that is, the slot’s message time is all used). The controller will transmit “OK” again after the message is recorded.

Example: To record the tail message (message # 3), send the following command with the controller unlocked: “*813”. The controller will respond with a CW “OK”. Key your radio, and transmit your voice message you want to record. Recording ends either when you unkey, or the maximum message length for the message is reached, whichever comes first. The controller will acknowledge recording your message with a CW “OK.”

3.12 *9: (Reserved for NHRC)

This command is reserved by NHRC for future expansion.

3.13 **: Reset Controller

Command ** is used to reset the controller to the power-up state for any reason.

The controller will send “NHRC 5” in CW.

4. Control Operator Commands

The NHRC-5 supports 80 different control operator settings arranged into ten groups of eight “software switches.” Each software switch represents an item in the controller that can be set to either on or off. Every switch is addressed by naming the group, then the item number. The first eight groups are accessible through the control operator prefix.

The format for all control operator commands is:

<ctl-op-prefix><group><item><state>

<ctl-op-prefix> The control operator prefix assigned by the repeater operator. (See Section 3.5 for information on programming command prefixes.)

<group> The group code for the switch to set or inquire. The valid range for <group> is 0 to 7. Groups 8 and 9 can only be accessed with the programming *0 command. (See Section 3.3 for information about *0: Unlocked Mode Control Operator Access.)

<item> The item number to set or inquire. The valid range for <item> is 0 to 7.

<state> is optional. If present, it is the state (1=on, 0=off) to which the control operator switch is to be set.

When <state> is not present, or after a successful control operator command that sets the switch state, the controller will respond by transmitting either the CW word “ON” or the CW word “OFF”, depending on the state of the particular switch.

For example, to set group 0 item 0 to enabled, the following command would be sent: *<ctl-op-prefix>001*.

The controller will respond by transmitting the word “ON” in CW.

All 80 of the control operator switches are saved when the controller’s state is saved. Saved state 0 is the power-up state, so if you want your changes to the control operator switches be restored after a power failure, it is important to save the controller’s setup. See section 3.4 for information on the save setup command.

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4.1 Group 0 Switches: Repeater Control

Group 0 contains switches that control the main repeater and access to the main repeater.

Group 0 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Repeater Enable	This is the repeater's master enable/disable control. Set this to 0 to disable the repeater.
1	Repeater CTCSS Required	Allows the repeater to be set into a CTCSS required mode when enabled. When disabled, the repeater is carrier access.
2	Key Up Delay ("Kerchunker Filter")	Allows the "kerchunker filter" to be enabled. The "kerchunker filter" requires a signal for more than 1/2 second before the repeater will begin to repeat, but only when the transmitter is not on.
3	Hang Timer Enabled	Normally enabled, but can be disabled when the repeater runs on battery power, or to discourage "kerchunkers."
4	Hang Timer Select	Allows the control operator to select which hang timer value is used. Allows the long (1) or short (0) timer to be selected.
5	DTMF Access Mode Select	Allows the control operator to place the repeater into DTMF access mode. In DTMF access mode, the repeater, , can only be activated from idle by sending the DTMF access prefix, followed by a 1 to enable the repeater. The repeater will remain active until either disabled with the DTMF access prefix followed by a 0, or the repeater remains idle for longer than the time specified in the DTMF access timer. See section 5.1 for more information on the DTMF access mode prefix.
6	Courtesy Tone Enabled	Allows the courtesy tone to be enabled or disabled.
7	Control Operator CTCSS required	When this switch is enabled, control operator commands will only be accepted when the command is received with a valid CTCSS tone.

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4.2 Group 1 Switches: More Repeater Control

Group 1 contains switches that control the main repeater and access to the main repeater.

Group 1 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Repeater Time-out Timer Enable	Allows the time-out timer on the main repeater to be enabled or disabled. Normally the time-out timer will be enabled. However, certain applications may require the time-out timer be disabled (nets, shuttle rebroadcast, etc.). Set this switch to 1 to enable the repeater time-out timer.
1	Time-out Timer Long Select	Allows the long (1) or short (0) timer to be selected.
2	“Dual Squelch” Enable	Setting this switch to 1 enables dual squelch mode. In “Dual-Squelch” mode, either the CAS or the CTCSS signal will cause the repeater to be accessed. This is sometimes called “OR-Squelch” mode.
3	DTMF Muting Enable	Enables DTMF tone muting. When enabled (1), the controller will mute the receiver <i>audio</i> to prevent received DTMF command tones from being broadcast over the repeater.
4	Control Receiver is Not Present	Setting this switch will cause the Control Receiver/Remote Base DTMF decoder to process commands immediately when the Remote Base CAS signal drops. Set this when the control receiver is not connected.
5	Link Port is Slaved Repeater	Setting this switch will cause the link port PTT to follow the main port PTT, for using the link port as a slave repeater.
6	Simplex Repeater Mode	When enabled (1) the controller will function as a “simplex repeater”, recording up to 90 seconds of audio from the input and playing it out the output when the input CAS drops.
7	Simplex Repeater Voice ID mode	When enabled (1), the controller will reserve message #0 (the initial ID track) from the space used for simplex mode, and it will play this track for the ID, rather than the CW ID.

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4.3 Group 2 Switches: Voice ID and Misc. Control

Group 2 controls the voice ID and tail messages.

Group 2 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Enable Voice Initial ID	When enabled (1), the initial voice ID message is present. If disabled (0), the CWID will play instead of the voice initial ID.
1	Enable Voice Normal ID	When enabled (1), the controller will play the normal ID message voice track (#1) for the "normal" ID. When disabled (0), the controller will play the CW ID for the normal ID.
2	Allow ID Stomp by Keyup	When enabled (1), will allow the controller to cancel a voice ID and play the CW ID if a user begins to transmit while the voice ID is playing.
3	Enable Voice Time-out Message	When set (1), enables the voice time-out message, instead of the CW time-out message "TO."
4	Digital Output Fan Control	When enabled (1), configures the digital output on the main repeater connector to be a fan control output. A fan connected to this output will run while the transmitter is keyed, and a programmable amount of time after the transmitter is unkeyed. When disabled, this input is controlled by the state of the Group 2 Item 5 switch.
5	Digital Output Control	If the automatic fan control is disabled (Group 2 Switch 4 is off/0) this switch can be used to turn the Fan Control digital output on and off.
6	Digital Audio Delay is Present on Main Port	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on the main repeater port.
7	Digital Audio Delay is present on Link/Remote Base Port	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on the link/remote base port.

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4.4 Group 3 Switches: Link/Remote Base Port Control

Group 3 contains switches that control the state and operation of the Link/Remote Base port.

Group 3 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Set Link Port Alert Mode	<p>When enabled (1), configures the link port into “Alert Mode.” In alert mode, a different courtesy tone is played when the main receiver drops if the link receiver is active.</p> <p>Note: The link audio is not repeated. Only the alert tone is present to indicate channel activity. This mode can be overridden by switch 1 or switch 2. This switch, as well as switches 1 and 2, can also be set with the link prefix. See Section 5.4.1 for more information on the Link/Remote Base Prefix.</p>
1	Set Link Port Receive Mode	<p>When enabled (1), configures the link port into “Receive Mode.” In receive mode, the link port audio is transmitted over the main repeater, but the main repeater is not transmitted over the link port. This mode can be overridden by switch 2.</p>
2	Set Link Port Transmit Mode	<p>When enabled (1), configures the link port into “Transmit Mode.” In this mode, the link receive audio is transmitted over the main repeater, and the main repeater’s receive audio is transmitted over the link.</p>
3	Link Port CTCSS Required	<p>Allows the link port to be set into a CTCSS required mode when enabled. When disabled, the link port is carrier access.</p>
4	Link Port “Dual Squelch” Enable	<p>Setting this switch to 1 enables dual squelch mode for the link/remote base port.</p>
5	Link Port Time-out Timer Enable	<p>Setting this switch enables the link port time-out timer. If this switch is off, the link port will not time-out..</p>
6	Link Port Time-out Timer Long Select	<p>Allows the long (1) or short (0) timer to be selected.</p>
7	Link Port Drops PTT to mute DTMF	<p>Setting this switch will cause the link port to drop PTT during DTMF muting..</p>

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4.5 Group 4 Switches: Auxiliary Audio Control

Group 4 contains switches that control the state of the auxiliary audio input.

Group 4 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Auxiliary Input Manual Control	When enabled (1), causes the Auxiliary Audio to be transmitted over the repeater
1	Auxiliary Input Automatic Control	When enabled (1), causes the Auxiliary Audio to be transmitted over the repeater when EXP1 is pulled to ground.
2	Auxiliary Input Auto-Mute	When enabled, the auxiliary input will be automatically muted whenever either the main or link receiver is active.
3	Alarm Input Enable	This switch, when enables, will cause the alarm tone to sound periodically if the EXP2 input is pulled or pulsed to ground. The alarm tone interval is set with timer #7
4	Reserved	Reserved for NHRC.
5	Reserved	Reserved for NHRC.
6	Drop TX to mute DTMF	When enabled (1), causes the controller to “drop” PTT on the main transmitter to mute DTMF. This might be useful if you wanted to play DTMF down the link. Note that DTMF Audio Muting (Group 1 switch 3) needs to be off (0) if you don’t want to mute the DTMF <i>audio</i> .
7	NHRC Test Mode	Reserved for NHRC.

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4.6 Group 5 Switches: CTCSS Encoder Control

Group 5 contains switches that allow the NHRC-5 to control CTCSS encoders.

Group 5 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Main Transmitter CTCSS encoder control	When enabled (1) digital output 1 (EXP5) provides an active-high output to control the main transmitter's CTCSS encoder. Used in conjunction with switch 1. See section 2.8.4.1 for information about the electrical connections for CTCSS encoder control.
1	Main Transmitter CTCSS encoder chicken-burst enable	Used in conjunction with switch 0. When disabled (0), the CTCSS encoder is only enabled when a valid input signal is present. When enabled (1), the CTCSS encoder is enabled until 200 milliseconds before the transmitter turns off.
2	Link Transmitter CTCSS encoder control	When enabled (1) digital output 2 (EXP6) provides an active-high output to control the link/remote base transmitter's CTCSS encoder. Used in conjunction with switch 3.
3	Link Transmitter CTCSS encoder "chicken-burst" enable	Used in conjunction with switch 2. When disabled (0), the CTCSS encoder is only enabled when a valid input signal is present. When enabled (1), the CTCSS encoder is enabled until 200 milliseconds before the transmitter turns off.
4	Reserved	Reserved for NHRC.
5	Reserved	Reserved for NHRC.
6	Reserved	Reserved for NHRC.
7	Reserved	Reserved for NHRC.

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4.7 Group 6 Switches: Expansion Outputs Mode Control

Group 6 contains switches which configure the expansion output

Group 6 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Port 1 Pulsed Mode.	When enabled (1), setting Port 1 to on will cause it to remain on for ½ second.
1	Port 2 Pulsed Mode.	When enabled (1), setting Port 2 to on will cause it to remain on for ½ second.
2	Port 3 Pulsed Mode.	When enabled (1), setting Port 3 to on will cause it to remain on for ½ second.
3	Port 4 Pulsed Mode.	When enabled (1), setting Port 4 to on will cause it to remain on for ½ second.
4	Reserved	Reserved for NHRC.
5	Reserved	Reserved for NHRC.
6	Reserved	Reserved for NHRC.
7	Reserved	Reserved for NHRC.

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4.8 Group 7 Switches: Expansion Outputs Control

Group 7 contains switches which control the 4 expansion output ports. Note that these ports can also be controlled with the Expansion Output Control prefix.

Group 7 Switches:

<u>Switch</u>	<u>Action</u>	<u>Description</u>
0	Port 1 Output Control	When set (1), port 1 will be in a logic 1 state. When clear (0), port 1 will be in a logic 0 state.
1	Port 2 Output Control	When set (1), port 2 will be in a logic 1 state. When clear (0), port 2 will be in a logic 0 state.
2	Port 3 Output Control	When set (1), port 3 will be in a logic 1 state. When clear (0), port 3 will be in a logic 0 state.
3	Port 4 Output Control	When set (1), port 4 will be in a logic 1 state. When clear (0), port 4 will be in a logic 0 state.
4	Reserved	Reserved for NHRC.
5	Reserved	Reserved for NHRC.
6	Reserved	Reserved for NHRC.
7	Reserved	Reserved for NHRC.

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4.9 Group 8 Switches: Programming Write Protect

Group 8 contains switches which enable or disable modification to controller data. These switches serve as a “write protect” to help prevent accidental reprogramming of repeater features. Each switch, when enabled (1), write protects its associated setup information. This entire group cannot be accessed by the control operator, it can only be accessed when the repeater is unlocked, by using the *0 command. (See Section 3.3 for information on the unlocked mode control operator access.)

Group 8 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Write Protect Control Group Setups	When enabled (1), causes the *1 command (Save Setup) to fail, effectively disallowing control groups to be saved.
1	Write Protect Command Prefixes	When enabled (1), causes the *2 Program Command Prefix command to fail, effectively disallowing modification of the command prefixes.
2	Write Protect Timers	When enabled (1), causes the *3 Set Timers command to fail, effectively disallowing modification of the timer values.
3	Reserved	Reserved for NHRC.
4	Reserved	Reserved for NHRC.
5	Reserved	Reserved for NHRC.
6	Write Protect CW Messages and Courtesy Tones	When enabled (1), causes the *70 and *71 commands to fail when new messages are specified, effectively disallowing modification of the CW ID and courtesy tones.
7	Write Protect Pre-recorded Vocabulary Tracks	When enabled (1), causes the *81 “record voice message” command to fail, effectively disallowing modification of the voice message tracks.

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4.10 Group 9 Switches: Control Operator Group Access

Group 9 contains switches which enable or disable control operator access to the control operator groups. This entire group cannot be accessed by the control operator. It can only be accessed when the repeater is unlocked, by using the *0 command. These switches allow the repeater operator to selectively disable control operator functions on a group-by-group basis, allowing more granularity of controller security. (See Section 3.3 for information on the unlocked mode control operator access.)

Group 9 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Enable Control Operator Access to Group 0	When enabled (1), allow the control operator to change the settings in Group 0.
1	Enable Control Operator Access to Group 1	When enabled (1), allow the control operator to change the settings in Group 1.
2	Enable Control Operator Access to Group 2	When enabled (1), allow the control operator to change the settings in Group 2.
3	Enable Control Operator Access to Group 3	When enabled (1), allow the control operator to change the settings in Group 3.
4	Enable Control Operator Access to Group 4	When enabled (1), allow the control operator to change the settings in Group 4.
5	Enable Control Operator Access to Group 5	When enabled (1), allow the control operator to change the settings in Group 5.
6	Enable Control Operator Access to Group 6	When enabled (1), allow the control operator to change the settings in Group 6.
7	Enable Control Operator Access to Group 7	When enabled (1), allow the control operator to change the settings in Group 7.

5. User Commands

This section describes commands that are available to the repeater users. Every command has a command prefix which is set by the repeater operator. The prefixes can be kept secret, so only certain users have access to certain functions. (See Section 3.5 for more information on programming command prefixes.)

Throughout this section of the manual, the command prefix will be shown as <prefix>, which must be replaced with the actual command prefix as programmed by the repeater operator.

5.1 DTMF Access

The NHRC-5 Repeater Controller supports a DTMF access mode which allows the repeater to be left in a secured disabled state, but users who know the DTMF access code can enable the repeater. The repeater reverts to the secured disabled state when either the repeater is idle for longer than the DTMF access mode timer, or a user sends the DTMF access code followed by a zero.

The repeater is put into DTMF access mode by setting control operator Group 0, Item 5 to enabled (1). (See section 4.1 for information about this control operator switch, section 3.5 for information on programming the DTMF access prefix and section 3.6 for information on setting the DTMF access timer.)

When the repeater is in the DTMF access mode, the DTMF access command is used as follows:

<prefix><state> where:

<prefix> is the DTMF access mode prefix.

<state> is 1 to enable the repeater. <state> is 0 to return the repeater to the secure disabled mode.

Example: If the repeater is in DTMF access mode, and the DTMF access prefix is "567", the repeater can be activated by sending "5671". At that time the repeater will remain on until either no activity occurs on the repeater for a period longer than the DTMF Access Mode timer or the repeater is manually deactivated by sending "5670".

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5.2 Expansion Digital Output Control

The NHRC-5 expansion digital outputs can be directly set with a user command.

Each output can be turned on, turned off, or have its state reported.

When an output is turned on, the controller will respond with the word “on” sent in CW. When an output is turned off, the controller will respond with the word “off” sent in CW. When an outputs state is checked, the controller will respond with either “on” or “off” sent in CW, depending on the output’s state.

To use the Digital Output Control feature, enter the following command:

<prefix><port #><state> where:

- <prefix>** is the Digital Output Control prefix as programmed by the repeater operator
- <port>** Is the expansion output number, from 1 to 4.
- <state>** Is 1 to turn the port on, 0 to turn the port off. The ports current state will be reported if the state digit is not sent.

Example: Assuming the Digital Output Control prefix is 99, if you want to set output 2 off, you can send "9920" to the controller. The controller will respond with “off” sent in CW. To test the state of output 3, you can send “993” to the controller; the controller will respond with either “on” or “off”, depending on the state of output 3.

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5.3 Load Saved Setup

The NHRC-5 supports two saved setups of all 80 control operator switches. (See section 3.4 for information about saving the controller state.)

This command allows users or control operators to select one of the preset repeater states.

The format for the load saved state command is:

<prefix><state-number> where:

<prefix> is the load saved state prefix as programmed by the repeater operator.

<state-number> is the state to load. Valid state numbers are 0 and 1.

Example: Assuming the Load Saved Setup prefix is set to 314159, and you want to select your “net mode”, saved as setup #1, send “3141591”. The controller will respond with the morse message “OK”.

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5.4 Remote Base

The NHRC-5 Repeater Controller supports a remote base radio which can be used as a link to another repeater system, a “slaved” repeater, or a remote base. The remote base prefix is used to control the state of the remote base port. The remote base port can be configured into four different modes:

- In “alert mode,” repeater users are alerted to remote-base channel activity by a different courtesy tone.
- “Receive mode” transmits the remote base audio over the main repeater, but the repeaters audio is not transmitted over the remote base.
- “Transmit mode” is a completely linked state where the remote base audio is transmitted over the repeater, and the repeater audio is transmitted over the repeater.
- The “Off” mode is an Off state where the remote base port is ignored.

5.4.1 Select remote base operating mode

To select a remote base operating mode, use the following command:

<prefix><mode> where:

<prefix> is the remote base prefix as programmed by the repeater operator.

<mode> is the remote base operating mode.

Remote Base Operating Modes

Mode	Description
0	Off
1	Alert Mode
2	Receive Mode
3	Transmit Mode

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5.5 Auxiliary Audio

The NHRC-5 Repeater Controller supports an auxiliary input. The Auxiliary Audio prefix is used to control the state of the Auxiliary Audio Input. The Auxiliary Audio Input can in one of three different modes:

- Off—Auxiliary Audio is not transmitted.
- On—Auxiliary Audio is transmitted continuously.
- Automatic—Auxiliary Audio is transmitted only when EXP1 is pulled to ground.

The Auxiliary Audio prefix can also be used to clear a site alarm caused by EXP2 being pulled to ground.

5.5.1 Select Auxiliary Audio operating mode

To select a auxiliary audio operating mode, use the following command:

<prefix><mode> where:

<prefix> is the remote base prefix as programmed by the repeater operator.

<mode> is the auxiliary audio operating mode.

Auxiliary Audio Operating Modes

Mode	Description
0	Auxiliary Audio Off
1	Auxiliary Audio On
2	Auxiliary Audio Automatic Mode
3	Clear Alarm

5.6 Audio Test

The NHRC-5 Repeater Controller has a built-in “audio test” feature that allows repeater users to get a true “first-hand” account of exactly how their radio sounds through the repeater system.

To use the audio test feature, use the following command:

<prefix><mode> where:

<prefix> is the audio test prefix as programmed by the repeater operator.

The controller will respond with “OK” in CW when the command is accepted. The user should then key up and transmit a test message, of up to 11 seconds, to the controller. When the user un-keys, the controller will play back the stored audio test message.

6. Appendices

6.1 Factory Defaults

6.1.1 Default Command Prefixes Table

Index	Description	Default Prefix
00	Control Operator	00
01	DTMF Access	01
02	Digital Output Control	02
03	Load Saved Setup	03
04	Remote Base Control	04
05	Auxiliary Audio Input Control	05
06	Audio Test	06
07	Unlock Controller	07

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6.1.2 Timer Defaults Table

Timer Number	Description	Multiplier	Timer Value	Effective Value
00	Hang Timer Long	.1	100	10.0
01	Hang Timer Short	.1	50	5.0
02	ID Timer	10	54	540
03	DTMF Access Timer	10	60	600
04	Time-Out Timer Long	1	180	180
05	Time-Out Timer Short	1	30	30
06	Fan Timer	10	12	120
07	Alarm Alert Interval	10	6	60
08	Tail Message Counter	1	0	0

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6.1.3 Courtesy Tone Component Tones Table

Tone Code	Tone
00	No tone
01	F4
02	F#4
03	G4
04	G#4
05	A4
06	A#4
07	B4
08	C5
09	C#5
10	D5
11	D#5
12	E5
13	F5
14	F#5
15	G5
16	G#5
17	A5
18	A#5
19	B5
20	C6
21	C#6
22	D6
23	D#6
24	E6
25	F6
26	F#6
27	G6
28	G#6
29	A6
30	A#6
31	B6

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6.1.4 CW (“Morse Code”) Character Table

Letter	Code
0	00
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	08
9	09
A	21
B	22
C	23
D	31
E	32
F	33
G	41
H	42
I	43
J	51
K	52
L	53
M	61
N	62
O	63
P	71
Q	70
R	72
S	73
T	81
U	82
V	83
W	91
X	92
Y	93
Z	90
Space	11
/	12

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6.2 Control Operator Controls

6.2.1 Control Operator Group 0 (Repeater Control) Operations Table

Group #	Item #	Function	Default	Comments
0	0	Repeater Enable	1	
0	1	Repeater CTCSS Required	0	
0	2	Key Up Delay (Kerchunk Filter)	0	
0	3	Hang Timer Enabled	1	
0	4	Hang Timer Short/Long Select	0	0=short, 1=long, see related timer values.
0	5	DTMF Access Mode	0	See related DTMF access code and timer information
0	6	Courtesy Tone Enabled	1	
0	7	Control Op CTCSS Required	0	

6.2.2 Control Operator Group 1 (Repeater Control II) Operations Table

Group #	Item #	Function	Default	Comments
1	0	Repeater Time-Out Timer Enable	1	See related timer value
1	1	Time-Out Long / Short	1	0=short, 1=long, see related timer values short time-out
1	2	Enable "Dual Squelch"	0	Allows CTCSS or CAS to provide valid CAS
1	3	Enable DTMF Muting	1	Repeater mutes touch tones
1	4	Control Receiver Is Not Present	0	Set to 1 with no control receiver
1	5	Link Port Is Slaved Repeater	0	Set to 1 for slaved repeater
1	6	Simplex Repeater Mode	0	
1	7	Simplex Repeater Voice Id	0	

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6.2.3 Control Operator Group 2 (Voice And Tail ID Messages) Operations Table

Group #	Item #	Function	Default	Comments
2	0	Enable Voice Initial Id	1	Plays CW ID if disabled. See CWID programming
2	1	Enable Voice Normal Id	1	Plays CW ID if disabled.
2	2	Allow ID Stomp By Key Up	1	ID reverts to CW when keyed over.
2	3	Enable Voice Time-Out Message	1	Plays CW "TO" when disabled
2	4	Digital Output/Fan Control	0	0=digital output, 1=fan control
2	5	Digital Output Control	0	1=on, 0=off
2	6	Delay Present On Repeater Port	0	NHRC-DAD installed on repeater.
2	7	Delay Present On Link/Remote-Base Port	0	NHRC-DAD installed on link/remote-base port.

6.2.4 Control Operator Group 3 (Link Port Control) Operations Table

Group #	Item #	Function	Default	Comments
3	0	Link Port Alert Mode	0	
3	1	Link Port Receive Mode	0	
3	2	Link Port Transmit Mode	0	
3	3	Link Port CTCSS Required	0	
3	4	Link Port Dual-Squelch Mode	0	
3	5	Link Port Time-Out Timer Enable	0	
3	6	Link Port Time-Out Timer Long	0	
3	7	Link Port Drops To Mute DTMF	0	

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6.2.5 Control Operator Group 4 (Auxiliary Audio Input Control) Operations Table

Group #	Item #	Function	Default	Comments
4	0	Auxiliary Audio Input Manual Control	0	1 for on
4	1	Auxiliary Audio Input Automatic Control	0	
4	2	Auxiliary Audio Input Auto-Mute Mode	0	
4	3	Alarm Input Enabled	0	
4	4	Reserved	0	Reserved for NHRC
4	5	Reserved	0	Reserved for NHRC
4	6	Drop main TX to mute DTMF	0	
4	7	NHRC Test Mode	0	Reserved for NHRC

6.2.6 Control Operator Group 5 (Reserved for NHRC)

Group #	Item #	Function	Default	Comments
5	0	Reserved	0	Reserved for NHRC
5	1	Reserved	0	Reserved for NHRC
5	2	Reserved	0	Reserved for NHRC
5	3	Reserved	0	Reserved for NHRC
5	4	Reserved	0	Reserved for NHRC
5	5	Reserved	0	Reserved for NHRC
5	6	Reserved	0	Reserved for NHRC
5	7	Reserved	0	Reserved for NHRC

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6.2.7 Control Operator Group 6 (Digital Output Mode Control) Operations Table

Group #	Item #	Function	Default	Comments
6	0	Port 1 Pulsed Mode	0	
6	1	Port 2 Pulsed Mode	0	
6	2	Port 3 Pulsed Mode	0	
6	3	Port 4 Pulsed Mode	0	
6	4	Reserved	0	Reserved for NHRC
6	5	Reserved	0	Reserved for NHRC
6	6	Reserved	0	Reserved for NHRC
6	7	Reserved	0	Reserved for NHRC

6.2.8 Control Operator Group 7 (Digital Output Control) Operations Table

Group #	Item #	Function	Default	Comments
7	0	Port 1 Output Control	0	
7	1	Port 2 Output Control	0	
7	2	Port 3 Output Control	0	
7	3	Port 4 Output Control	0	
7	4	Reserved	0	Reserved for NHRC
7	5	Reserved	0	Reserved for NHRC
7	6	Reserved	0	Reserved for NHRC
7	7	Reserved	0	Reserved for NHRC

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6.2.9 Control Operator Group 8 (Programming Write Protect) Operations Table

Group #	Item #	Function	Default	Comments
8*	0	Write Protect Control Group Setups	0	
8*	1	Write Protect Prefixes	0	
8*	2	Write Protect Timers	0	
8*	3	Reserved	0	Reserved for NHRC
8*	4	Reserved	0	Reserved for NHRC
8*	5	Reserved	0	Reserved for NHRC
8*	6	Write Protect CW Messages & Courtesy Tones	0	
8*	7	Write Protects Pre-Recorded Vocabulary Tracks	1	Protects tracks 0-95 against accidental modification

6.2.10 Control Operator Group 9 (Control Operator Group Access) Operations Table

Group #	Item #	Function	Default	Comments
9*	0	Enable Access To Group 0	1	
9*	1	Enable Access To Group 1	1	
9*	2	Enable Access To Group 2	1	
9*	3	Enable Access To Group 3	1	
9*	4	Enable Access To Group 4	1	
9*	5	Enable Access To Group 5	1	
9*	6	Enable Access To Group 6	1	
9*	7	Enable Access To Group 7	1	

* Controller must be unlocked to access Groups 8 and 9

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6.3 Voice Messages

Message Number	Usage
0	Initial ID message
1	Normal ID message 1
2	Normal ID message 2
3	Time-out message
4	Tail message/courtesy tone
5	Link Off message
6	Link On message
7	Audio Test message

6.4 Terminology and Abbreviations

Term Description

CAS Carrier Activated Squelch, where receipt of a signal, with or without CTCSS will activate the controller.

CW Continuous Wave signals, commonly using “Morse Code.” The term “CW” refers to the radio emission type, while “Morse Code” refers to the signaling type used. Typically, they are incorrectly used interchangeably.

Digital Audio Delay (DAD) Digital Audio Delay (DAD) removes squelch crashes and allows DTMF tones to be fully muted.

DTMF Also known as “Touch Tone®” codes.

Dual Squelch “Dual Squelch,” also known as CAS or CTCSS mode, allows the repeater to be configured with a tight squelch for users without CTCSS, but allows a valid CTCSS to access the repeater even when the signal is not quiet enough to open the carrier squelch.

ID Identification.

PTT Push-to-Talk.

Unlock Code A special password used to enable programming of the controller.

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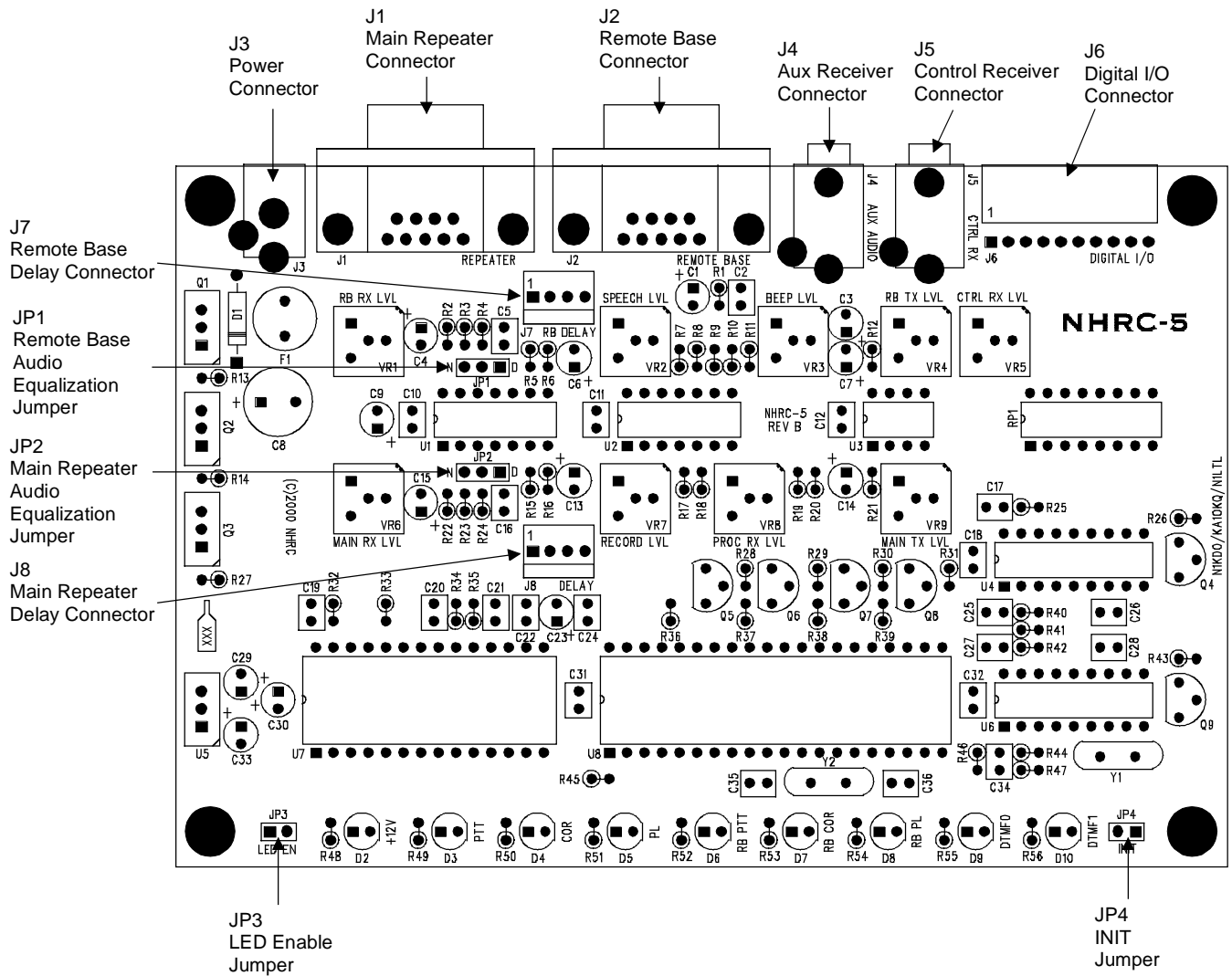
7. Circuit Board

7.1 Interconnections

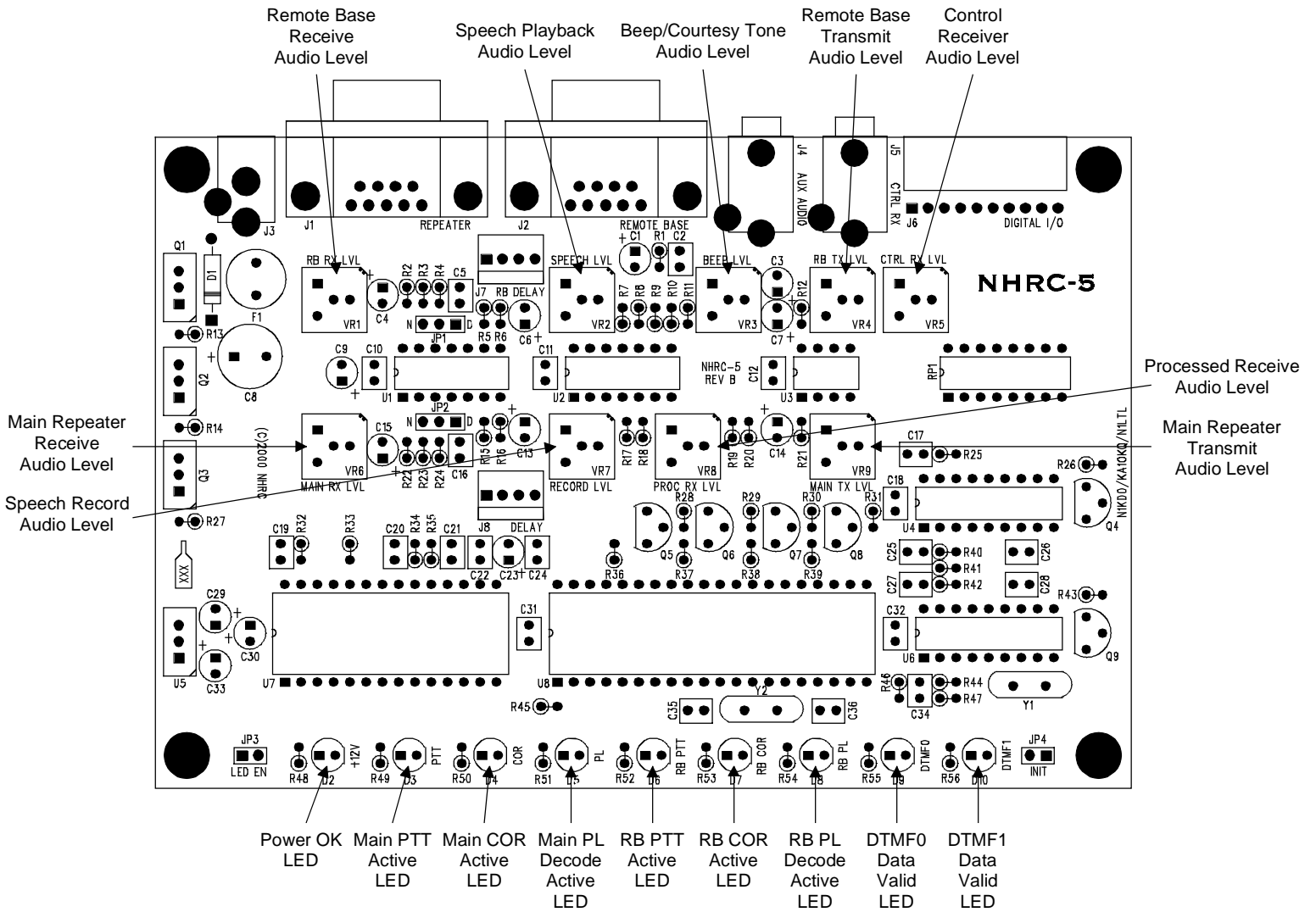
Connector	Name	Purpose
J1	“REPEATER”	Connects the repeater transmit and receive audio, PTT, CAS, fan control to the controller
J2	“REMOTE BASE”	Connected the remote base transmit and receive audio, PTT and CAS to the controller
J3	Power	Supplies DC power to the controller
J4	“AUX AUDIO”	Connects Auxiliary Audio to the controller
J5	“CTRL RX”	Connects Control Receiver Audio to the controller
J6	“DIGITAL I/O”	Allows the controller owner to interface external devices to the controller.
J7	“RB DELAY”	Supplies power and audio signals to an optional NHRC-DAD digital audio delay for the remote base port
J8	“DELAY”	Supplies power and audio signals to an optional NHRC-DAD digital audio delay for the repeater port

The following pages contain detailed views of the NHRC-5 connectors and controls.

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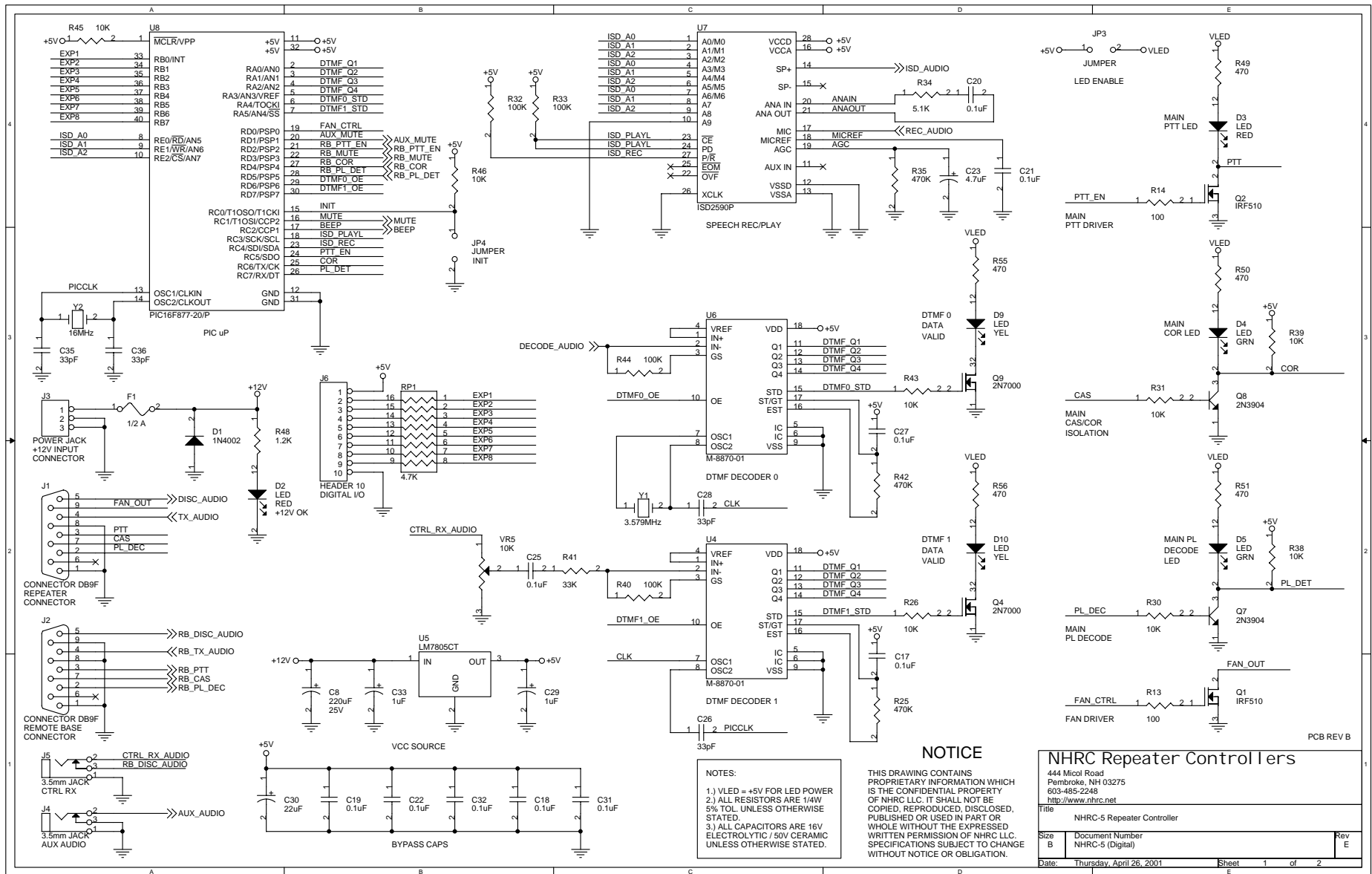


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8. Schematics

The following two pages are the schematic diagram for the Revision “B” Version of the NHRC-5 Repeater Controller.



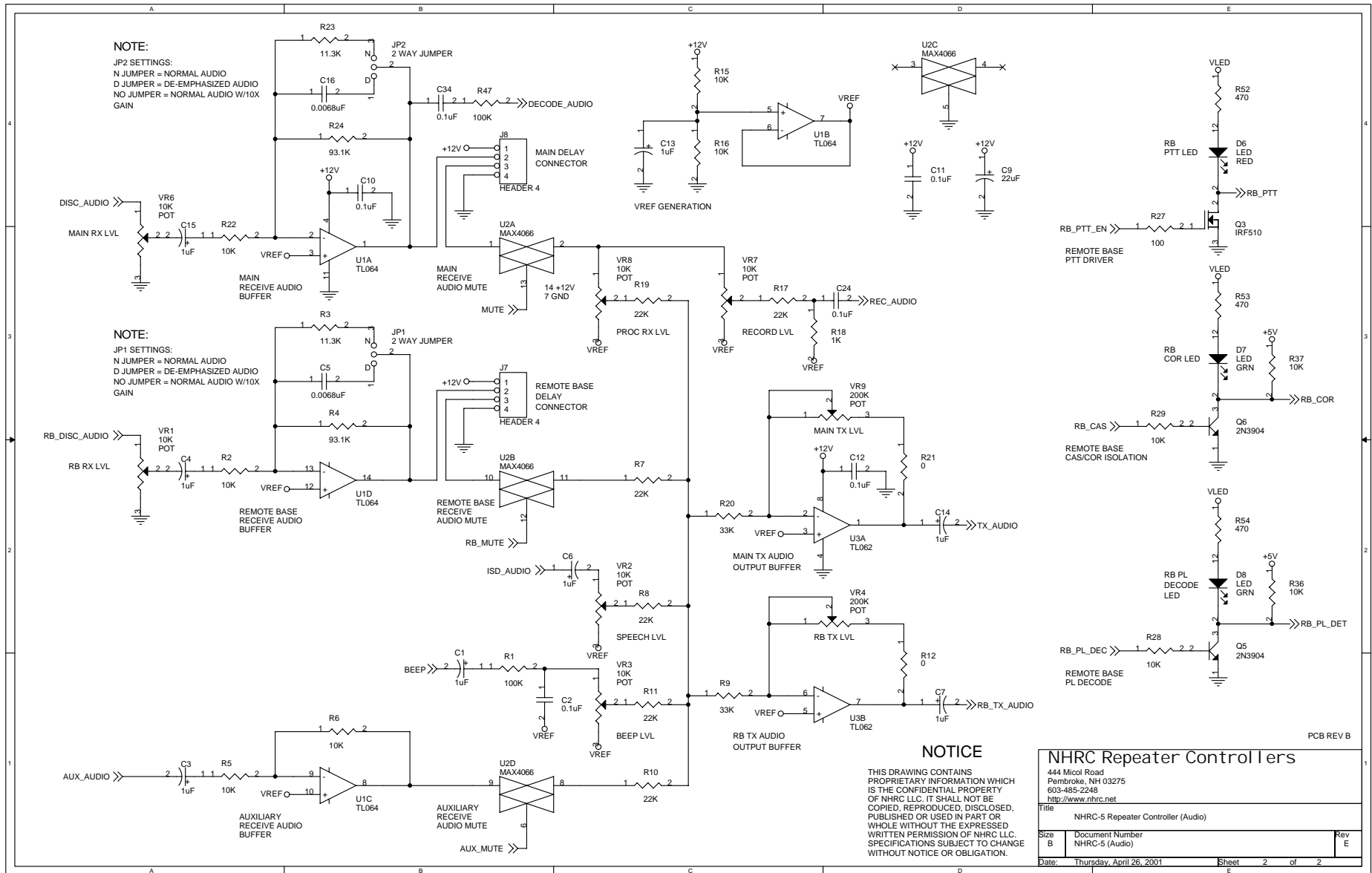
NOTES:
 1.) VLED = +5V FOR LED POWER
 2.) ALL RESISTORS ARE 1/4W
 5% TOL. UNLESS OTHERWISE
 STATED.
 3.) ALL CAPACITORS ARE 16V
 ELECTROLYTIC / 50V CERAMIC
 UNLESS OTHERWISE STATED.

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NHRC Repeater Controllers
 444 Micol Road
 Pembroke, NH 03275
 603-485-2248
<http://www.nhrc.net>

Title		NHRC-5 Repeater Controller	
Size	Document Number	NHRC-5 (Digital)	
B			Rev E

Date: Thursday, April 26, 2001 Sheet 1 of 2



NOTE:
 JP2 SETTINGS:
 N JUMPER = NORMAL AUDIO
 D JUMPER = DE-EMPHASIZED AUDIO
 NO JUMPER = NORMAL AUDIO W/10X GAIN

NOTE:
 JP1 SETTINGS:
 N JUMPER = NORMAL AUDIO
 D JUMPER = DE-EMPHASIZED AUDIO
 NO JUMPER = NORMAL AUDIO W/10X GAIN

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NHRC Repeater Controllers			
444 Micol Road Pembroke, NH 03275 603-485-2248 http://www.nhrc.net			
Title NHRC-5 Repeater Controller (Audio)			
Size B	Document Number NHRC-5 (Audio)	Rev E	
Date: Thursday, April 26, 2001	Sheet 2	of 2	

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9. Parts List

The following is the bill of materials for revision "B" of the NHRC-5 Repeater Controller.

NHRC-5 Repeater Controller
Bill Of Materials
 Revised: Tuesday, March 13, 2001
 Revision: A

Item	Qty.	Ref.	Schematic Value		Description	Mfg.	Mfg. P/N
1	10	C1	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C3	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C4	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C6	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C7	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C13	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C14	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C15	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C29	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
		C33	1uF		1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K
2	16	C2	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C10	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C11	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C12	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C17	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C18	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C19	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C20	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C21	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C22	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C24	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C25	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C27	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
		C31	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA
C32	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA		
C34	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA		
3	2	C16	0.0068uF		0.0068uF 50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA
		C5	0.0068uF		0.0068uF 50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA
4	1	C8	220uF	25V	220uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM221
5	2	C30	22uF		22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220
		C9	22uF		22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220
6	1	C23	4.7uF		4.7uF 50V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1HM4R7
7	4	C26	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA
		C28	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA
		C35	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA
		C36	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA
8	1	D1	1N4002		1A 100V Silicon Rectifier	Diodes Inc	1N4002
9	3	D2	LED	RED	Red T1¼ LED	Lite-On	LTL-4203
		D3	LED	RED	Red T1¼ LED	Lite-On	LTL-4203
		D6	LED	RED	Red T1¼ LED	Lite-On	LTL-4203
10	4	D4	LED	GRN	Green T1¼ LED	Lite-On	LTL-4233
		D5	LED	GRN	Green T1¼ LED	Lite-On	LTL-4233
		D7	LED	GRN	Green T1¼ LED	Lite-On	LTL-4233
		D8	LED	GRN	Green T1¼ LED	Lite-On	LTL-4233
11	2	D9	LED	YEL	Yellow T1¼ LED	Lite-On	LTL-4253
		D10	LED	YEL	Yellow T1¼ LED	Lite-On	LTL-4253
12	1	F1	1/2 A		1.1A Polyswitch	Raychem	RUE110
13	2	JP1	2 WAY JUMPER		3 Circuit Header, .100" Straight	Molex	22-03-2031
		JP2	2 WAY JUMPER		3 Circuit Header, .100" Straight	Molex	22-03-2031
14	2	JP4	JUMPER		2 Circuit Header, .100" Straight	Molex	22-03-2021
		JP3	JUMPER		2 Circuit Header, .100" Straight	Molex	22-03-2021
15	2	J2	CONNECTOR DB9F		DB9F Right Angle Connector 0.318" PCB mount	NorComp	182-009-212-531

NHRC-5 User Guide

Item	Qty.	Ref.	Schematic Value	Description	Mfg.	Mfg. P/N
		J1	CONNECTOR DB9F	DB9F Right Angle Connector 0.318" PCB mount	NorComp	182-009-212-531
16	1	J3	POWER JACK	Coaxial Power Jack, Right Angle PCB mount	Switchcraft	RAPC712
17	2	J4	3.5mm JACK	3.5mm 2 Circuit Right Angle Jack, PCB mt.	Cui-Stack	MJ-3536(N)
		J5	3.5mm JACK	3.5mm 2 Circuit Right Angle Jack, PCB mt.	Cui-Stack	MJ-3536(N)
18	1	J6	HEADER 10	10 Circuit Header, .100" Right Angle w/ lock	Molex	22-05-3101
19	2	J7	HEADER 4	4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041
		J8	HEADER 4	4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041
20	3	Q1	IRF510	N Channel HEXFET	IRF	IRF510
		Q2	IRF510	N Channel HEXFET	IRF	IRF510
		Q3	IRF510	N Channel HEXFET	IRF	IRF510
21	2	Q9	2N7000	N Channel MOSFET	Fairchild	2N7000
		Q4	2N7000	N Channel MOSFET	Fairchild	2N7000
22	4	Q5	2N3904	NPN Transistor	Fairchild	2N3904
		Q6	2N3904	NPN Transistor	Fairchild	2N3904
		Q7	2N3904	NPN Transistor	Fairchild	2N3904
		Q8	2N3904	NPN Transistor	Fairchild	2N3904
23	1	RP1	4.7K	4.7K x 8 Isolated Resistor Pack	Bourns	4116R-001-472
24	6	R1	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
		R32	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
		R33	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
		R40	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
		R44	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
		R47	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
25	20	R2	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R5	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R6	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R15	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R16	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R22	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R26	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R28	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R29	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R30	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R31	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R36	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R37	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R38	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R39	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R43	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R45	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
		R46	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
26	2	R3	11.3K	11.3K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 11K3
		R23	11.3K	11.3K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 11K3
27	2	R4	93.1K	93.1K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 93K1
		R24	93.1K	93.1K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 93K1
28	6	R7	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
		R8	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
		R10	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
		R11	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
		R17	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
		R19	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
29	3	R9	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K
		R20	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K
		R41	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K
30	3	R13	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R
		R14	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R
		R27	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R
31	1	R18	1K	1K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 1K0
32	3	R25	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K
		R35	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K
		R42	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K
33	1	R34	5.1K	5.1K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 5K1
34	1	R48	1.2K	1.2K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 1K2

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Item	Qty.	Ref.	Schematic Value		Description	Mfg.	Mfg. P/N
35	8	R49	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R50	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R51	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R52	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R53	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R54	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R55	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
		R56	470		470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R
36	2	R12	0		Zero Ohm ¼ W Jumper	Yaeg0	ZOR-25-B
		R21	0		Zero Ohm ¼ W Jumper	Yaeg0	ZOR-25-B
37	1	U1	TL064		Quad JFET Input Op-Amp	TI	TL064CN
38	1	U2	MAX4066		Quad SPST Analog Switch	Maxim	MAX4066
39	1	U3	TL062		Dual JFET Input Op-Amp	TI	TL062CP
40	2	U6	M-8870-01		DTMF Decoder	Teltone	M-8870-01
		U4	M-8870-01		DTMF Decoder	Teltone	M-8870-01
41	1	U5	LM7805CT		5V 1.0A Voltage Regulator	Nat'l Semi	LM340T-5.0
42	1	U7	ISD2590P		90 sec. Voice Recorder/Playback	ISD	ISD2590P
43	1	U8	PIC16F877-20/P		Microcontroller w/ 8K Flash Memory	Microchip	PIC16F877-20/P
44	7	VR1	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR2	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR3	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR5	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR6	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR7	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		VR8	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
		45	2	VR9	200K	POT	200K 6mm Carbon Trimpot
VR4	200K			POT	200K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B25
46	1	Y1	3.579MHz		16MHz Crystal	ECS	ECS-160-20-4
47	1	Y2	16MHz		3.579545MHz Crystal	ECS	ECS-35-17-4
Additional Items							
48	1				NHRC-5 PCB rev B	NHRC	NHRC-5 PCB rev B
49	1				40 Pin DIP Socket	Mill-Max	110-99-640-41-001
50	2				18 Pin DIP Socket	Mill-Max	110-99-318-41-001
51	2				14 Pin DIP Socket	Mill-Max	110-99-314-41-001
52	1				8 Pin DIP Socket	Mill-Max	110-99-308-41-001
53	1				10 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3107
54	2				4 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3047
55	18				Crimp Terminal for Molex Housing	Molex	08-50-0114
56	6				Shorting Jumpers	3M	929950-00-1

Note: Do not populate C34, C36 and Y2

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10. NHRC LLC Limited Warranty

NHRC LLC warrants that its assembled and tested products will be free from defects in materials and workmanship for a period of NINETY (90) DAYS from the date of shipment. During this period, NHRC LLC will repair or replace, at our option, any of our products that fail as a result of defects in materials or workmanship. NHRC LLC's liability will be limited to parts, labor, and return shipping for this period.

NHRC LLC warrants that its kit products will contain components that are free from defects in materials and workmanship for a period of THIRTY (30) DAYS from the date of shipment. During this period, NHRC will replace any of the components in a kit ONCE. Subsequent replacement of any component any subsequent times is completely at the discretion of NHRC LLC, and may require the complete return of the kit.

In no case will NHRC LLC be liable for products damaged by improper wiring (including, but not limited to, over-voltage or application of reverse polarity), physical damage resulting from misuse and/or abuse of the product, neglect, or acts of God (lightning, floods, etc.).

Unauthorized modification of a NHRC product will void the warranty on the modified product.

In no case will NHRC LLC be liable for any direct, consequential, or incidental loss or damage resulting from the use or inability to use any of its products.

Some states or countries do not allow the limitation of incidental or consequential damages, so the paragraph above may not apply to you.

This warranty applies only to the original purchaser of the product; proof of purchase must be presented to receive warranty service.

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