

NHRC

REPEATER CONTROLLERS

NHRC-6

User Guide

Software Version: 1.10

User Guide Version: 2004-Mar-01

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Thank You!

Thank you for purchasing the NHRC-6 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-6 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-6 are:

- Two radio ports
- Can support the following configurations:
 - two duplex repeaters
 - duplex repeater with link radio
 - two back-to-back simplex radios
- Unique courtesy tones to indicate selected receiver port.
- Saves five different configuration setups.
- 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.

1.1 Controller Architecture

The NHRC-6 has two radio ports. Each radio port supports a receiver and a transmitter.

Each receiver is individually configurable. Receiver configuration includes such parameters as receiver enable (on/off), access mode (CAS, CAS **and** CTCSS, CAS **or** CTCSS, and DTMF,) timeout timer enable, and DTMF muting. Each receiver can specify which transmitter(s) will be used to repeat the receiver’s audio.

Each transmitter is also individually configurable. Transmitter controls include transmitter enable (on/off), hang time enable, courtesy tone enable, ID enable and selection of one of two CW ID messages.

The architecture of the NHRC-6 allows the controller to be used in a variety of different applications. These applications include simultaneous control of two repeaters, each with its own ID message, control of a repeater with a link radio, including linking modes compatible with IRLP and full-duplex link environments, as well as the controller forming a “bridge” in conjunction with two simplex radios, allowing simple and reliable linking of completely separate radio systems.

1.2 Sending commands

All of the controller’s commands are sent by DTMF (Touch-Tone®) sequences that are received on either port. 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.

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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.

1.3 ID Messages

The controller supports two CW ID messages. Each transmitter can have either CW ID message selected, allowing the capability of having a different ID on each port.

The ID message will play when the controller is initially "awakened", and, if the controller transmits again, after the period set by the ID timer. 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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1.4 “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.

2. Electrical Connections

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

- power
- port 1 and port 2 radios
- NHRC-DAD digital audio delay boards

It is intended for the repeater operator to use in the planning and installation of the NHRC-6 Repeater Controller into a repeater system.

2.1 Input and Output Signal Levels.

Control signals into the NHRC-6 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 Radio Connectors

The controller interfaces to the radios through the “J1 REPEATER 1” and “J2 REPEATER 2” connectors.

J1 and J2 are Female DB9 Connectors.

Two male DB9 Connectors are included with the controller.



Male DB-9 Connector

J1 REPEATER 1 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-6 has a digital output that is intended to control a fan on the repeater’s transmitter(s). 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 3.6.2 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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J2 REPEATER 2 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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2.4 Delay Connectors

The NHRC-6 supports one or two optional NHRC-DADs, (CODEC digital audio delays), to reduce squelch crashes and fully mute DTMF tones.

Jacks “J5 RECEIVER 1 DELAY” and “J4 RECEIVER 2 DELAY” are provided on the controller to interface NHRC-DADs.

Jacks J4 and J5 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.

J5 RECEIVER 1 DELAY and J4 RECEIVER 2 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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2.5 Audio Level Adjustment

2.5.1 Overview:

Because of the variety of applications that the NHRC-6 can be used for, it is nearly impossible to present “cookbook” step-by-step alignment instructions. This section of the manual will describe how the audio processing works, describe what each control does, and list some basic guidelines for the adjustment of the controller audio.

2.5.2 Description of Audio Processing:

The NHRC-6 uses analog switching and audio mixing to route audio from the receivers and tone sources to the transmitters.

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

Repeater 1’s receiver audio is passed into the controller through potentiometer VR5, 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 J5 to the *optional* digital audio delay board for squelch tail elimination. If the digital audio delay is not present, J5 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 switches U2A and/or U2C. The gated audio is supplied to the repeater 1 transmitter mix bus via through mixer resistor R16, and balanced into the repeater 2 transmitter mix bus through the U3D buffer and VR3 level control. Beep audio for transmitter 1 is supplied by the MPU, filtered through the C15/R15/C12 network, has it’s level set with potentiometer VR6, and is supplied to transmitter 1’s mix bus through resistor R24. Transmitter 1’s master audio level is adjusted with potentiometer VR8.

Repeater 2’s receiver audio is passed into the controller through potentiometer VR1, and then buffered through audio amplifier U1D 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 U7, and through connector J4 to the *optional* digital audio delay board for squelch tail elimination. 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. After the digital audio delay connector, the main receiver audio is gated through analog switches U2B and/or U2D. The gated audio is supplied to the repeater 2 transmitter mix bus via through mixer resistor R9, and balanced into the repeater 1 transmitter mix bus through the U3A buffer and VR7 level control. . Beep audio for transmitter 2 is supplied by the MPU, filtered through the C1/R7/C6 network, has it’s level set with potentiometer VR2, and is supplied to transmitter 2’s mix bus through resistor R4. Transmitter 1’s master audio level is adjusted with potentiometer VR4.

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2.5.3 Description of Controls:

VR1 sets the receiver 2 audio input level into the controller, and, more critically, into the DTMF decoder for receiver 2.

VR2 sets the beep level for transmitter 2

VR3 is a “balance” control that sets the level of receiver 1 into transmitter 2.

VR4 is the transmitter 2 output audio level control.

VR5 sets the receiver 1 audio input level into the controller, and, more critically, into the DTMF decoder for receiver 1.

VR6 sets the beep level for transmitter 1.

VR7 is a “balance” control that sets the level of receiver 2 into transmitter 1.

VR8 is the transmitter 1 master level control.

2.5.4 Audio Level Adjustment:

Recommended equipment:

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

Procedure:

The reference level will be a 1 KHz tone at 3 KHz deviation. Since the controller contains two identical audio chains, this manual will describe the alignment for the receiver 1/transmitter 1 chain. The controls for the receiver 2/transmitter 2 chain will be identified in parentheses.

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 jumpers JP2 and JP1 to the appropriate pins, depending on whether you are using “discriminator” or “normal” audio from the receivers. Set the jumper(s) from the center pin to the “N” pin for normal audio, or from the center pin to the “D” pin for discriminator audio.
2. Transmit on the receiver’s input frequency and send some DTMF tones. Adjust VR5 (VR1) until the DTMF tones are reliably decoded, as indicated by LED D10 (D11). Make sure all 16 tones can be reliably decoded.

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3. Enable the audio path(s) you plan to use. See section 5.4 for information on how to do this. If you are planning to use full-duplex on either port, see the instructions in section 4.5 and 4.6 to set the controller to allow duplex operation on those ports.
4. Transmit your test signal through the controller and use VR8 (VR4) to adjust the audio level sent to your transmitter. Note that this control adjusts the level going into your transmitter, and the IDC or deviation control on the transmitter will set the maximum deviation that the transmitter can send. If the VR8 (VR4) control is set too high, then the deviation limiting in your transmitter will clip or otherwise limit the transmitted audio, and your repeater audio will suffer.
5. Turn off your test signal. Listen to the level of the courtesy tone. Use VR6 (VR2) to adjust the level of the beep tones from the controller. This control sets the level for the courtesy tone and the CW ID.
6. Repeat these steps as needed for the 2nd port.
7. VR7 sets the level of receiver 2 into transmitter 1. Do not adjust this control until you have first performed the alignment specified above for both ports. Use your test signal and deviation meter to set the proper level here.
8. VR3 sets the level of receiver 1 into transmitter 2. Do not adjust this control until you have first performed the alignment specified above for both ports. Use your test signal and deviation meter to set the proper level here.

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2.6 The LED Indicators

The NHRC-6 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-6 LED Indicator Functions

LABEL	COLOR	USE
+12V	Red	Power Indicator
TX1 PTT	Red	Repeater 1 Transmit
RX1 COR	Green	Repeater 1 Unsilenced
RX1 PL	Amber	Repeater 1 CTCSS Detect
TX2 PTT	Red	Repeater 2 Transmit
RX2 COR	Green	Repeater 2 Unsilenced
RX2 PL	Amber	Repeater 2 CTCSS Detect
DTMF 1	Yellow	Repeater 1 DTMF Detect
DTMF 2	Yellow	Repeater 2 DTMF Detect

All LEDs, except the +12V LED, can be disabled to reduce power consumption by removing jumper JP4.

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** (JP3, located adjacent to LED D2.)
- **Apply power to the NHRC-6.** After a short pause, the controller will transmit “NHRC 6” 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 (05) to the controller.** The controller should respond with a CW “OK.”
- **Use the *2 command to program command prefix 05: the unlock prefix.** To program the unlock code to 314159, send the following command: *2 05 314159. 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** (JP3, located adjacent LED D2.)

You should program the CW IDs at this time. See Sections 3.10.1 for information on programming the CW IDs. This is also a good time to program all the command prefixes. See Section 3.5 for information on programming command prefixes.

The controller’s defaults that are loaded at initialization specify that both transmitter 1 and transmitter 2 are **not duplex** radios. This feature allows users with conventional radios (not full-duplex repeaters) attached to these ports to successfully change the programming of the controller. If you have full-duplex radios attached to one of both of these ports, you must set the “transmitter duplex select” control operator switch to 1 in order to use the respective ports with repeater(s). See section 4.5 and 4.6 for information on these switches.

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

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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, and the two CW IDs.

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

Procedure:

- **Install the initialize jumper** (JP3, located adjacent to LED D2.)
- **Apply power to the controller.** After a short delay of about 10 seconds, the controller will sent the CW message "NHRC 6".
- **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.

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, this command allows access to groups 8 and 9 which are not accessible using the control operator prefix (discussed in Section 4). Groups 8 and 9 help to implement controller security by:

- controlling write access to controller data, and
- controlling control operator access to groups 0 through 7.

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.

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3.4 *1: Save Setup

The NHRC-6 Repeater Controller has five “saved configuration setups” that allow the repeater operator to save five presets of all 80 of the control operator switches.

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

This feature comes in handy when you want to give users the ability to flip between preprogrammed operating modes, without the worry of them making changes and adjustments. Here’s how you do it:

1. Decide how you want the repeater to perform on power-up.
2. Modify switches in groups 0 thru 7 to achieve desired operation... see section 4 for information on programming group switches.
3. When you have it configured to meet your power-up requirements save it as setup 0.
4. Next, decide how you want the repeater to perform in an alternate mode... say “mode B”.
5. Modify switches in groups 0 thru 7 to achieve “mode B” characteristics.
6. When you have it the way you want it, save it as a setup other than setup 0.
7. Repeat steps 4, 5 & 6 to create additional operating modes.
8. After you’ve saved everything in memory, lock the controller giving users only the “load saved setup” codes. Note that the controller does not have to be unlocked to load a saved setup.

3.4.1 Save configuration setup

*1<n> where:

<n> specifies the setup number to save. Valid range is 0 to 4.

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.

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

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3.5 *2: Program Command Prefixes

Every command accepted by the NHRC-6 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	Link State Control
05	05	Unlock Controller

Example: To set the DTMF access prefix to 4321, send the following command with the controller unlocked: “*2 01 4321”. The controller will respond with a CW “OK” if the command is accepted.

Note: The spaces in the sample command string are for illustration purposes only. In actuality, there are no spaces.

⇒ **Note:** For security reasons, *command prefix 5 (the unlock code) cannot be changed unless the initialize jumper (JP3) 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.

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3.6 *3: Set timers

The NHRC-6 has 14 timers that control various parameters of the repeaters.

Depending on the timer's application within the controller, the timer will have 0.01, 0.1, 1.0, or 10-second resolution. The timer resolution indicates 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.

3.6.1 Description of Timers

Timer 00 (hang timer long) and 01 (hang timer short) are "hang" timers. One of these timers can be selected for each transmitter port. The hang timer specifies the amount of time the transmitter stays on after the receiver input signal goes away. This is sometimes called the "tail" timer. Each transmitter can select no hang timer, the short hang timer, or the long hang timer. The resolution of the hang timers is .1 seconds.

Timers 02 (ID timer, transmitter 1) and 03 (ID timer, transmitter 2) are the ID timers for transmitter 1 and transmitter 2, respectively. These timers control how long the period is before a CW ID message is sent. These timers are set in tens of seconds. For example, to set a 9 minute ID timer interval: 9 minutes is 540 seconds, so the timer would be set for 54.

Timer 04 is the DTMF access mode timer. In DTMF access mode, the repeater is activated by sending a DTMF command. The repeater can be de-activated with another DTMF command, or if a period of inactivity occurs. The DTMF access mode timer sets the amount of inactivity before the repeater automatically deactivates. This timer has a 10 second resolution.

Timers 05 (timeout timer long) and 06 (timeout timer short) control the timeout period. Timeout is the maximum amount of time a receiver can be active before the repeater assumes a stuck mike and stops repeating that receiver. These timers are set with a 1 second resolution.

Timer 07 (fan timer) controls how long the fan control output will remain active after the PTT signal is released. This timer uses 10-second resolution.

Timer 08 (courtesy tone front porch delay, transmitter 1) and timer 09 (courtesy tone front porch delay, transmitter 2) control how long the controller waits from the input signal becoming inactive before it sends the courtesy tone. This timer has a .01 second resolution.

Timer 10 (transmitter 1 CW pitch) and Timer 12 (transmitter 2 CW pitch) allow the repeater owner to tailor the tone of the transmitted CW characters. They are technically not timers, but parameter settings. The CW pitch can be set to any of the 32 tones shown in section 6.1.3.

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Timer 11 (transmitter 1 CW speed) and Timer 13 (transmitter 2 CW speed) allow the repeater owner to tailor the speed of the transmitted CW characters. The CW speed can be adjusted from 5 to 30 WPM (words per minute.)

3.6.2 Program a timer

The NHRC-6 timers are programmed as follows:

***3<nn><time>** where:

- <nn>** specifies the timer to set. Valid range is 00 to 07. 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-6 Timers, by Number

Timer No.	Description	Timer Resolution	Default Value
00	Hang Timer Long	.1	10.0 seconds
01	Hang Timer Short	.1	5.0 seconds
02	ID Timer, transmitter 1	10	540 seconds (9 minutes)
03	ID Timer, transmitter 2	10	540 seconds (9 minutes)
04	DTMF Access Timer	10	600 seconds (10 minutes)
05	Time-out Timer Long	1	180 seconds
06	Time-out Timer Short	1	30 seconds
07	Fan Timer	10	120 seconds
08	Transmitter 1 Courtesy Tone “front porch” timer	.01	.5 seconds
09	Transmitter 2 Courtesy Tone “front porch” timer	.01	.5 seconds
10	Transmitter 1 CW pitch	0-31	20 (C6)
11	Transmitter 1 CW speed	5-30	20 WPM
12	Transmitter 2 CW pitch	0-31	20 (C6)
13	Transmitter 2 CW speed	5-30	20 WPM

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Examples:

To program the ID timer to 6 minutes (480 seconds), send the following command with the controller unlocked: "*3 02 48". 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: "*3 00 200". 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 sections 4.5 and 4.6 for instructions on setting a transmitter to select the hang timer parameters.

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 *70 command is used to program or play the CW ID. The *71 command is used to program or play the courtesy tones.

3.10.1 Program the CW ID

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

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

<n> Is the ID message selector, 0 for ID 1, and 1 for ID 2

<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 CW ID 2, the following command would be entered: *70 1 31 32 11 62 01 52 63 12 72.

To play the CW ID, the following command would be entered: *701

Note: The spaces in the sample command string are for illustration purposes only. In actuality, there are no spaces.

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3.10.2 Program or Play Courtesy Tones

The NHRC-6 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 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 “dd” and tone “tt”.

Duration is in 10 mSec 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 receiver 1 into transmitter 1 courtesy tone #0, (four 50 mSec bursts of notes E5, G5, B5, D6) would be programmed like: *71 0 0517 0520 0524 0527.

Courtesy Tone Uses

<u>Tone</u>	<u>Use</u>
0	Receiver 1 into Transmitter 1 courtesy tone.
1	Receiver 1 into Transmitter 2 courtesy tone.
2	Receiver 2 into Transmitter 1 courtesy tone.
3	Receiver 2 into Transmitter 2 courtesy tone.
4	(reserved for NHRC)
5	(reserved for NHRC)
6	(reserved for NHRC)
7	Controller unlocked courtesy tone

3.10.3 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 #3 (receiver 2 into transmitter 2 courtesy tone) to play the CW letter “L”, send *71 3 9953.

3.11 *8: (*Reserved for NHRC*)

This command is reserved by NHRC for future expansion.

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 6” in CW.

4. Control Operator Commands

The NHRC-6 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: Receiver 1 Control

Group 0 contains switches that control receiver 1.

Group 0 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Receiver Enable	This switch is the “master” switch for receiver 1. If this switch is set to off (0), the receiver 1 is completely disabled. Set this switch to 1 to enable receiver 1.
1	CTCSS Required	Sets the receiver into CTCSS required mode when enabled. When disabled, the repeater is carrier access.
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 receiver to become active, and be repeated if so configured. This is sometimes called “OR-Squelch” mode.
3	DTMF Access Mode Select	Allows the control operator to place the receiver into DTMF access mode. In DTMF access mode, the receiver can only be activated from idle by sending the DTMF access prefix, followed by a 1 to enable the repeater. The receiver 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.
4	Reserved	Reserved for NHRC
5	Reserved	Reserved for NHRC
6	Receiver 1 to Transmitter 1 enable	This switch, when set, will cause audio received on receiver 1 to be repeated over transmitter 1.
7	Receiver 1 to Transmitter 2 enable.	This switch, when set, will cause audio received on receiver 1 to be repeated over transmitter 2.

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4.2 Group 1 Switches: Receiver 1 Control

Group 1 contains switches that control receiver 1.

Group 1 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Key Up Delay ("Kerchunker Filter")	Allows the "kerchunker filter" to be enabled. The "kerchunker filter" requires a signal for more than ½ second before the receiver will be considered active, but only when the transmitter is not on.
1	Receiver Time-out Timer Enable	Allows the time-out timer on the receiver 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 receiver time-out timer.
2	Time-out Timer Long Select	Allows the long (1) or short (0) timer to be selected.
3	Reserved	Reserved for NHRC
4	Audio Delay is Installed	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on this receiver port.
5	Reserved	Reserved for NHRC
6	Mute DTMF into transmitter 1	When set, DTMF tones received on this receiver will not be repeated through transmitter 1.
7	Mute DTMF into transmitter 2	When set, DTMF tones received on this receiver will not be repeated through transmitter 2.

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4.3 Group 2 Switches: Receiver 2 Control

Group 2 contains switches that control receiver 2.

Group 2 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Receiver Enable	This switch is the “master” switch for receiver 2. If this switch is set to off (0), the receiver 2 is completely disabled. Set this switch to 1 to enable receiver 2.
1	CTCSS Required	Sets the receiver into CTCSS required mode when enabled. When disabled, the repeater is carrier access.
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 receiver to become active, and be repeated if so configured. This is sometimes called “OR-Squelch” mode.
3	DTMF Access Mode Select	Allows the control operator to place the receiver into DTMF access mode. In DTMF access mode, the receiver can only be activated from idle by sending the DTMF access prefix, followed by a 1 to enable the repeater. The receiver 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.
4	Reserved	Reserved for NHRC
5	Reserved	Reserved for NHRC
6	Receiver 2 to Transmitter 1 enable	This switch, when set, will cause audio received on receiver 2 to be repeated over transmitter 1.
7	Receiver 2 to Transmitter 2 enable.	This switch, when set, will cause audio received on receiver 2 to be repeated over transmitter 2.

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4.4 Group 3 Switches: Receiver 2 Control

Group 2 contains switches that control receiver 2.

Group 3 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Key Up Delay ("Kerchunker Filter")	Allows the "kerchunker filter" to be enabled. The "kerchunker filter" requires a signal for more than ½ second before the receiver will be considered active, but only when the transmitter is not on.
1	Receiver Time-out Timer Enable	Allows the time-out timer on the receiver 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 receiver time-out timer.
2	Time-out Timer Long Select	Allows the long (1) or short (0) timer to be selected.
3	Reserved	Reserved for NHRC
4	Audio Delay is Installed	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on this receiver port.
5	Reserved	Reserved for NHRC
6	Mute DTMF into transmitter 1	When set, DTMF tones received on this receiver will not be repeated through transmitter 1.
7	Mute DTMF into transmitter 2	When set, DTMF tones received on this receiver will not be repeated through transmitter 2.

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4.5 Group 4 Switches: Transmitter 1 Control

Group 4 contains switches that control the state and operation of Transmitter 1.

Group 4 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Transmitter Enabled	This switch is the “master” switch for Transmitter 1. If this switch is set to off (0), then transmitter 1 is completely disabled. Set this switch to 1 to enable transmitter 1.
1	Hang Timer Enable	This switch enables the hang timer on this transmitter when on (1).
2	Hang Timer Short/Long Select.	Allows the control operator to select which hang timer value is used. Allows the long (1) or short (0) timer to be selected.
3	ID Enable	This switch turns on the CW ID for this transmitter
4	ID Select	This switch selects which CW ID plays for this transmitter. Set to 0 to select CW ID #1, set to 1 to select CW ID #2
5	Duplex Select	This switch must be set to on (1) for full-duplex operation to occur on this transmitter. Set the switch to off (0) to use a conventional half-duplex radio on this port.
6	Receiver 1 Courtesy Tone Enable	This switch enables the courtesy tone for receiver 1 to play out this transmitter.
7	Receiver 2 Courtesy Tone Enable	This switch enables the courtesy tone for receiver 2 to play out this transmitter.

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4.6 Group 5 Switches: Transmitter 2 Control

Group 4 contains switches that control the state and operation of Transmitter 2.

Group 5 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Transmitter Enabled	This switch is the “master” switch for Transmitter 2. If this switch is set to off (0), then transmitter 1 is completely disabled. Set this switch to 1 to enable transmitter 2.
1	Hang Timer Enable	This switch enables the hang timer on this transmitter when on (1).
2	Hang Timer Short/Long Select.	Allows the control operator to select which hang timer value is used. Allows the long (1) or short (0) timer to be selected.
3	ID Enable	This switch turns on the CW ID for this transmitter
4	ID Select	This switch selects which CW ID plays for this transmitter. Set to 0 to select CW ID #1, set to 1 to select CW ID #2
5	Duplex Select	This switch must be set to on (1) for full-duplex operation to occur on this transmitter. Set the switch to off (0) to use a conventional half-duplex radio on this port.
6	Receiver 1 Courtesy Tone Enable	This switch enables the courtesy tone for receiver 1 to play out this transmitter.
7	Receiver 2 Courtesy Tone Enable	This switch enables the courtesy tone for receiver 2 to play out this transmitter.

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4.7 Group 6 Switches: Digital Output Control

Group 6 contains switches that control the digital output/fan control output.

Group 6 Switches:

<u>Switch</u>	<u>Name</u>	<u>Description</u>
0	Digital Output Select	When enabled (1), the fan control output works as a digital output. Set this to off (0) to use the fan control output on a fan.
1	Digital Output Control	This switch sets the state of the digital output, when group 6, switch 0 (above) is set to 1. Set this switch to on (1) to turn on the digital output, or set it to off (0) to turn off the digital output.
2	Digital Output Pulsed Mode.	When enabled (1), the digital output will be turned off ½ second after it is turned on, resulting in a ½ second pulse on the digital output.
3	Reserved	Reserved for NHRC.
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: Reserved for NHRC

The Group 7 switches are reserved for NHRC. Do not change the state of these switches, they should all be left off.

Group 7 Switches:

<u>Switch</u>	<u>Action</u>	<u>Description</u>
0	Reserved	Reserved for NHRC.
1	Reserved	Reserved for NHRC.
2	Reserved	Reserved for NHRC.
3	Reserved	Reserved for NHRC.
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	Reserved	Reserved for NHRC.

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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-6 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 "567 1". 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 Digital Output Control

The NHRC-6 fan control output can be configured as a digital output for control applications, by setting control operator group 6 switch 0 to on (1). See section 4.7 for information on this setting. When the digital output is enabled, its on/off state can be controlled with this command.

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

If the fan control output is not configured as a digital output, the controller will respond to any of these commands with “ERR” sent in CW.

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

<prefix><state> where:

<prefix> is the Digital Output Control prefix as programmed by the repeater operator

<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 turn the output off, you can send "990" to the controller. The controller will respond with “off” sent in CW. To test the state of the output you can send “99” to the controller; the controller will respond with either “on” or “off”, depending on the state of the output.

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5.3 Load Saved Setup

The NHRC-6 supports five 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 to 4.

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

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5.4 Link State Control

The NHRC-6 Repeater Controller supports two independent radios that can be linked together in a variety of fashions. The controller can run two duplex repeaters, a duplex repeater with a link radio, or two conventional (half-duplex) radios in a back-to-back configuration to form a bridge between two different radio systems.

The link state commands allow the user to configure how audio is routed and how the controller operates the two radios in any of the above scenarios.

Each receiver can be routed to none, either, or both transmitters. This command allows the user to specify the receiver routing.

To select a link state mode, use the following command:

<prefix><rx1-routing-digit><rx2-routing-digit> where:

<prefix> is the link state control prefix as programmed by the repeater operator.

<rx1-routing-digit> Selects the destination(s) for audio from receiver 1. See the table below.

<rx2-routing-digit> Selects the destination(s) for audio from receiver 2. See the table below.

Link State Routing Digits

Routing-digit	Destination(s)
0	Nowhere. Off.
1	Transmitter 1
2	Transmitter 2
3	Transmitter 1 and Transmitter 2

Examples:

These examples assume that the Link State Control prefix is set to "04" (the default.)

To route receiver 1 to transmitter 1, and route receiver 2 nowhere (off) send "04 1 0".

To route receiver 1 to transmitter 1, and receiver 2 to transmitter 2 (for separate repeaters), send "04 1 2".

To route receiver 1 to transmitters 1 and 2, and receiver 2 to transmitters 1 and 2 (two repeaters linked together) send "04 3 3".

To route receiver 1 to transmitter 2, and receiver 2 to transmitter 1, (back-to-back half-duplex radios) send "04 2 1".

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5.5 Unlock Controller

The NHRC-6 Repeater Controller normally operates in the “locked” mode, where all the user commands described in Section 5 are active. In order to modify critical controller parameters, such as timer lengths, CW IDs, and program command prefixes, the controller must be “unlocked.”

The Unlocked mode commands are described in Section 3 of this manual.

To unlock the controller: send the unlock code, release PTT, then listen for the special “controller unlocked” courtesy tone. The default unlock code is 05, but you have probably changed that when you went through the initialization procedure (see Quick Start, section 3.1.) Note: If you have forgotten the unlock code, you will have to re-initialize the controller.

To lock the controller, send “#”, see section 1.4.

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	Link State Control	04
05	Unlock Controller	05

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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, Transmitter 1	10	54	540
03	ID Timer, Transmitter 2	10	54	540
04	DTMF Access Timer	10	60	600
05	Time-Out Timer Long	1	180	180
06	Time-Out Timer Short	1	30	30
07	Fan Timer	10	12	120
08	Transmitter 1 Courtesy Tone “front porch” timer	.01	50	.5
09	Transmitter 2 Courtesy Tone “front porch” timer	.01	50	.5
10	Transmitter 1 CW pitch	N/Aa	20	C6 tone
11	Transmitter 1 CW speed	1	20	20 WPM
12	Transmitter 2 CW pitch	N/A	20	C6 tone
13	Transmitter 2 CW speed	1	20	20 WPM

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6.1.3 Courtesy Tone 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 Switches: Receiver 1 Control

Group #	Item #	Function	Default	Comments
0	0	Receiver Enable	1	
0	1	CTCSS Required	0	
0	2	Dual Squelch Enable	0	
0	3	DTMF Access Mode Enable	0	See sections 5.1 and 3.5
0	4	Reserved	0	
0	5	Reserved	0	
0	6	Receiver 1 to Transmitter 1 enable	1	
0	7	Receiver 1 to Transmitter 2 enable	0	

6.2.2 Control Operator Group 1 Switches: Receiver 1 Control

Group #	Item #	Function	Default	Comments
1	0	Key Up Delay (“kerchunker filter”)	0	
1	1	Receiver Time-Out Timer Enable	1	See section 3.6
1	2	Long Time Out Timer Select	1	1 = long, 2=short, See section 3.6
1	3	Reserved	0	
1	4	Audio Delay Present	0	Set to 1 if audio delay is present on this receiver port.
1	5	Reserved	0	
1	6	Mute DTMF into Transmitter 1	1	
1	7	Mute DTMF into Transmitter2	1	

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6.2.3 Control Operator Group 2 Switches: Receiver 2 Control

Group #	Item #	Function	Default	Comments
2	0	Receiver Enable	1	
2	1	CTCSS Required	0	
2	2	Dual Squelch Enable	0	
2	3	DTMF Access Mode Enable	0	See sections 5.1 and 3.5
2	4	Reserved	0	
2	5	Reserved	0	
2	6	Receiver 2 to Transmitter 1 enable	0	
2	7	Receiver 2 to Transmitter 2 enable	1	

6.2.4 Control Operator Group 3 Switches: Receiver 2 Control

Group #	Item #	Function	Default	Comments
3	0	Key Up Delay (“kerchunker filter”)	0	
3	1	Receiver Time-Out Timer Enable	1	See section 3.6
3	2	Long Time Out Timer Select	1	1 = long, 2=short, See section 3.6
3	3	Reserved	0	
3	4	Audio Delay Present	0	Set to 1 if audio delay is present on this receiver port.
3	5	Reserved	0	
3	6	Mute DTMF into Transmitter 1	1	
3	7	Mute DTMF into Transmitter2	1	

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6.2.5 Control Operator Group 4 Switches: Transmitter 1 Control

Group #	Item #	Function	Default	Comments
4	0	Transmitter Enable	1	
4	1	Hang Timer Enable	1	See Section 3.6
4	2	Long Hang Timer Select	0	0=short, 1=long, see Section 3.6
4	3	ID Enable	1	
4	4	ID Select	0	0=CW ID 1, 1=CW ID 2, See section 3.10.1
4	5	Duplex Select	0	0=half-duplex, 1=full-duplex
4	6	Receiver 1 Courtesy Tone Enable	1	
4	7	Receiver 2 Courtesy Tone Enable	1	

6.2.6 Control Operator Group 5 Switches: Transmitter 2 Control

Group #	Item #	Function	Default	Comments
5	0	Transmitter Enable	1	
5	1	Hang Timer Enable	1	See Section 3.6
5	2	Long Hang Timer Select	0	0=short, 1=long, see Section 3.6
5	3	ID Enable	1	
5	4	ID Select	0	0=CW ID 1, 1=CW ID 2, See section 3.10.1
5	5	Duplex Select	0	0=half-duplex, 1=full-duplex
5	6	Receiver 1 Courtesy Tone Enable	1	
5	7	Receiver 2 Courtesy Tone Enable	1	

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

Group #	Item #	Function	Default	Comments
6	0	Digital Output Select	0	0=fan control, 1=digital output control
6	1	Digital Output Control	0	0=off (open), 1=on (pulled to ground)
6	2	Digital Output Pulsed Mode	0	0=on/off, 1=pulsed
6	3	Reserved	0	Reserved for NHRC
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 Switches: Reserved for NHRC

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

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 Terminology and Abbreviations

<u>Term</u>	<u>Description</u>
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

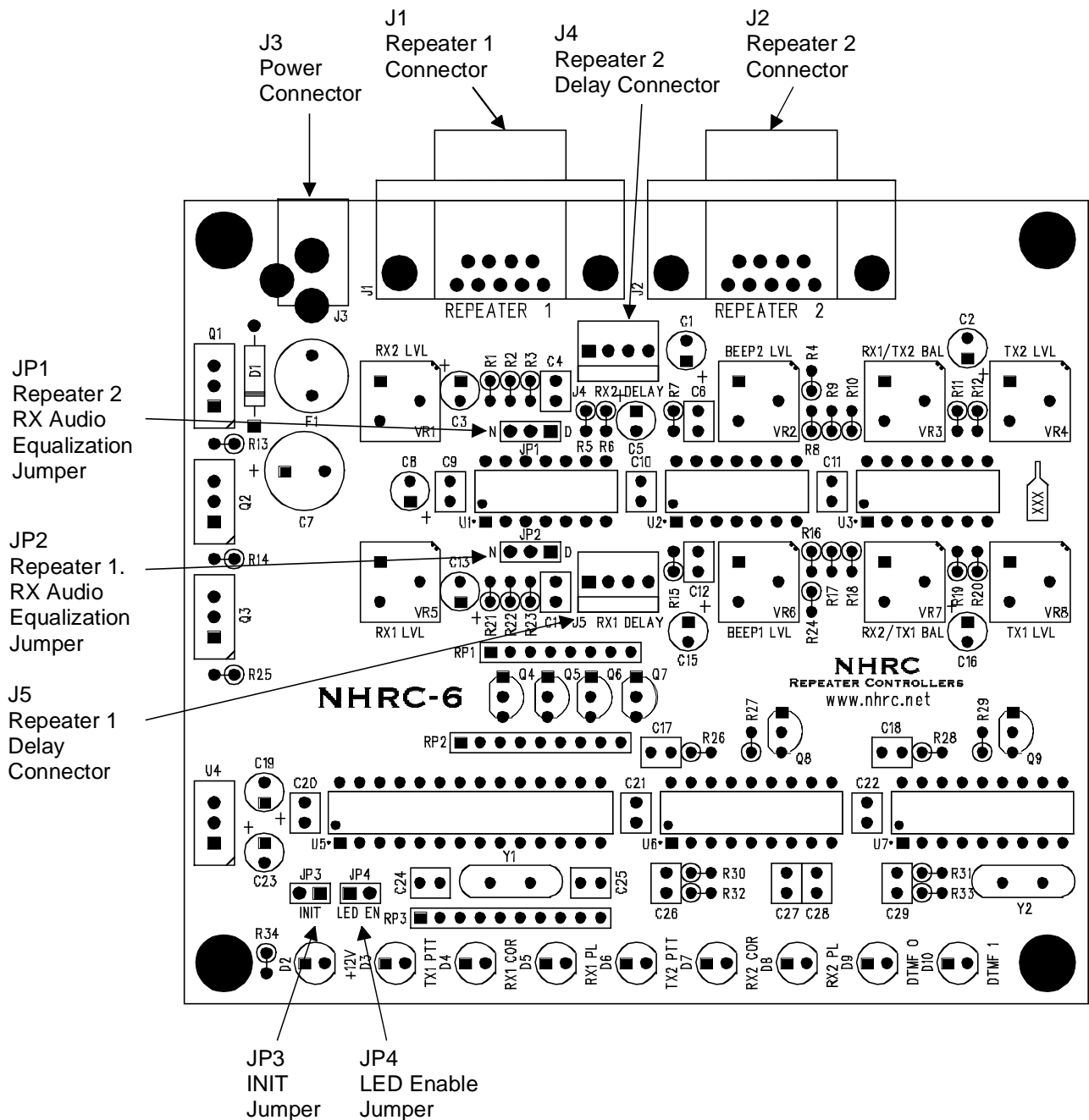
Connector	Name	Purpose
J1	“REPEATER 1”	Connects repeater 1 transmit and receive audio, PTT, CAS, fan control to the controller
J2	“REPEATER 2”	Connects repeater 2 transmit and receive audio, PTT, and CAS to the controller
J3	Power	Supplies DC power to the controller
J4	“RX2 DELAY”	Supplies power and audio signals to an optional NHRC-DAD digital audio delay for the REPEATER 2 port. A jumper must be installed between pins 2 and 3 if no DAD is connected.
J5	“RX1 DELAY”	Supplies power and audio signals to an optional NHRC-DAD digital audio delay for the REPEATER 1 port. A jumper must be installed between pins 2 and 3 if no DAD is connected.

7.2 Jumpers

Connector	Name	Purpose
JP1	N D (receiver 2 equalization)	Set jumper between N and center pin for flat audio. Set jumper between D and center pin for de-emphasized audio.
JP2	N D (receiver 1 equalization)	Set jumper between N and center pin for flat audio. Set jumper between D and center pin for de-emphasized audio.
JP3	INIT	Initialize the controller to factory defaults if power is applied while jumper is installed. Also used to program unlock prefix.
JP4	LED EN	This jumper enables the LED status indicators. It can be removed to reduce the current demand of the controller for special applications.

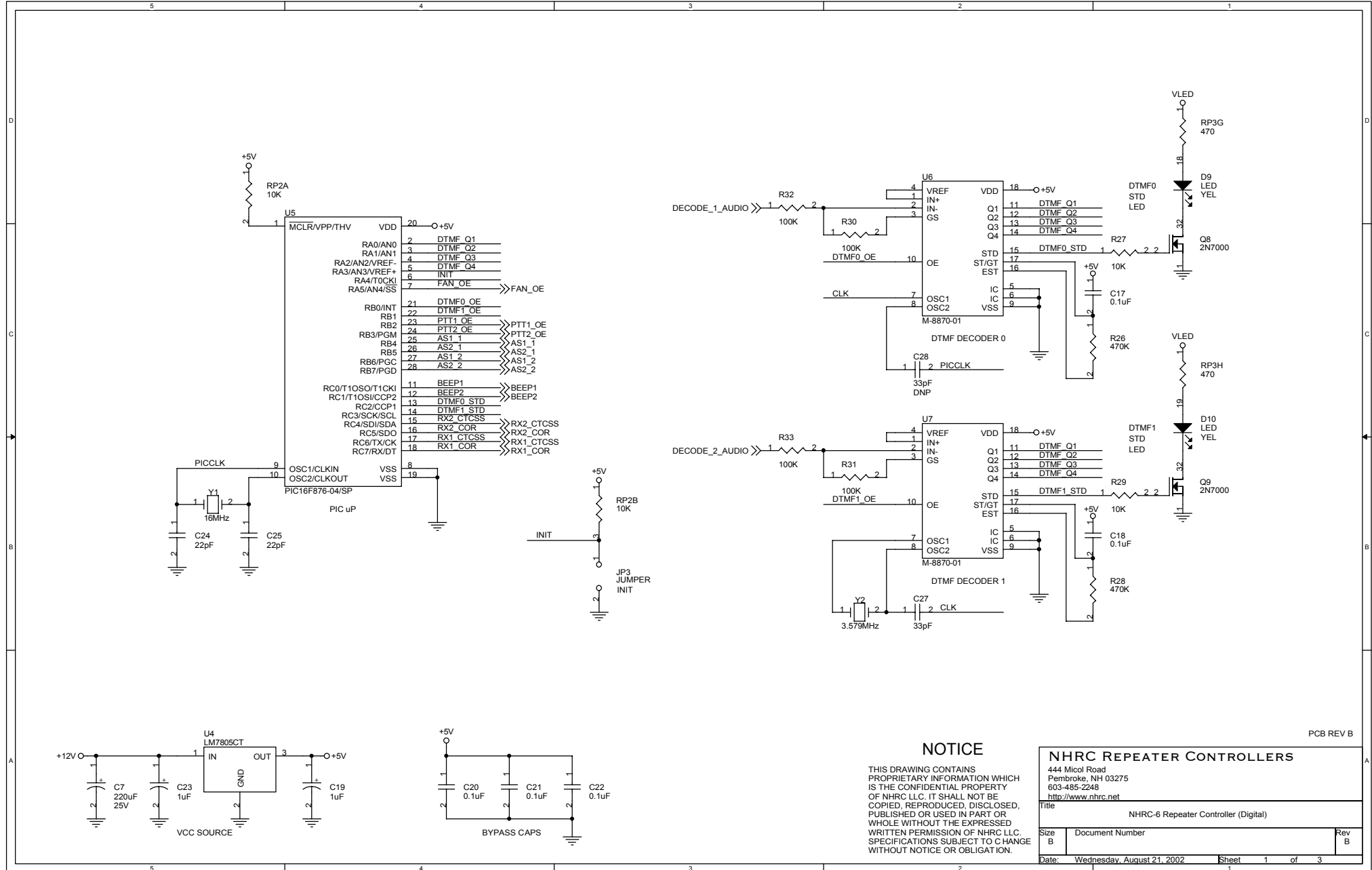
The following pages contain detailed views of the NHRC-6 connectors and controls.

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8. Schematics

The following three pages are the schematic diagram for Revision A of the NHRC-6 Repeater Controller.



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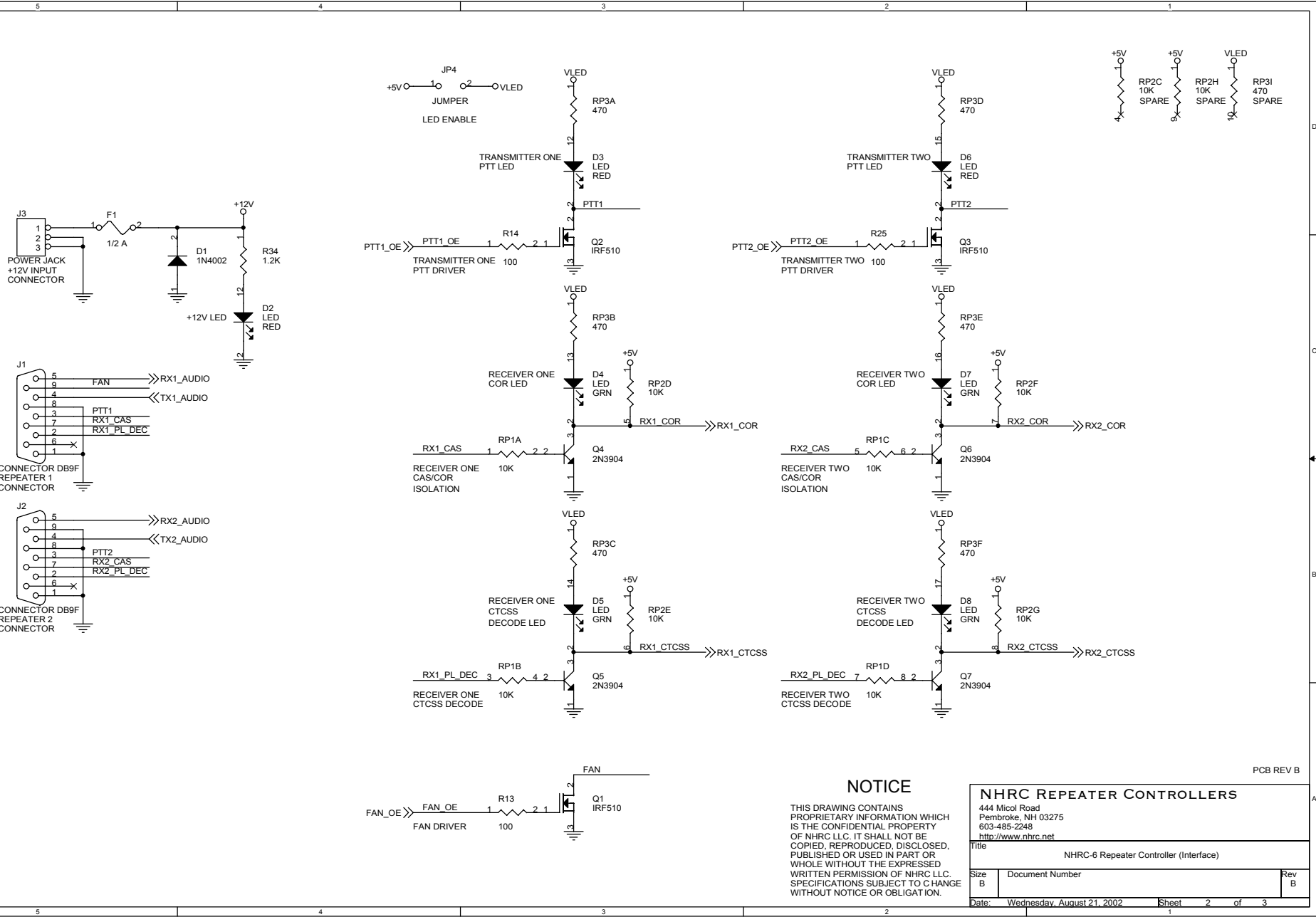
NHRC REPEATER CONTROLLERS

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

Title: NHRC-6 Repeater Controller (Digital)

Size B	Document Number	Rev B
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Date: Wednesday, August 21, 2002 Sheet 1 of 3



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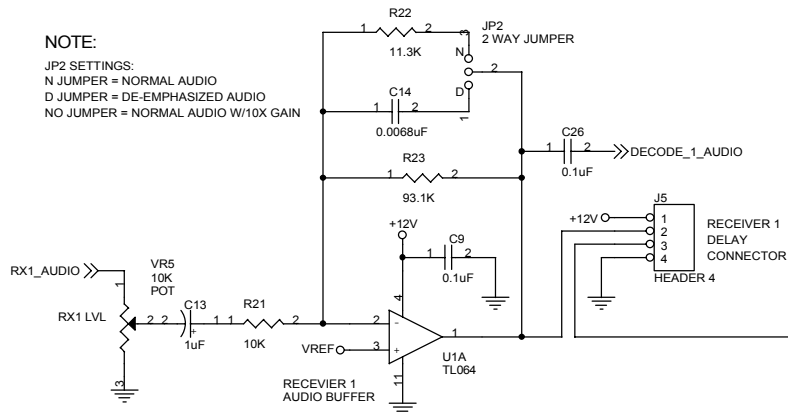
PCB REV B

NHRC REPEATER CONTROLLERS

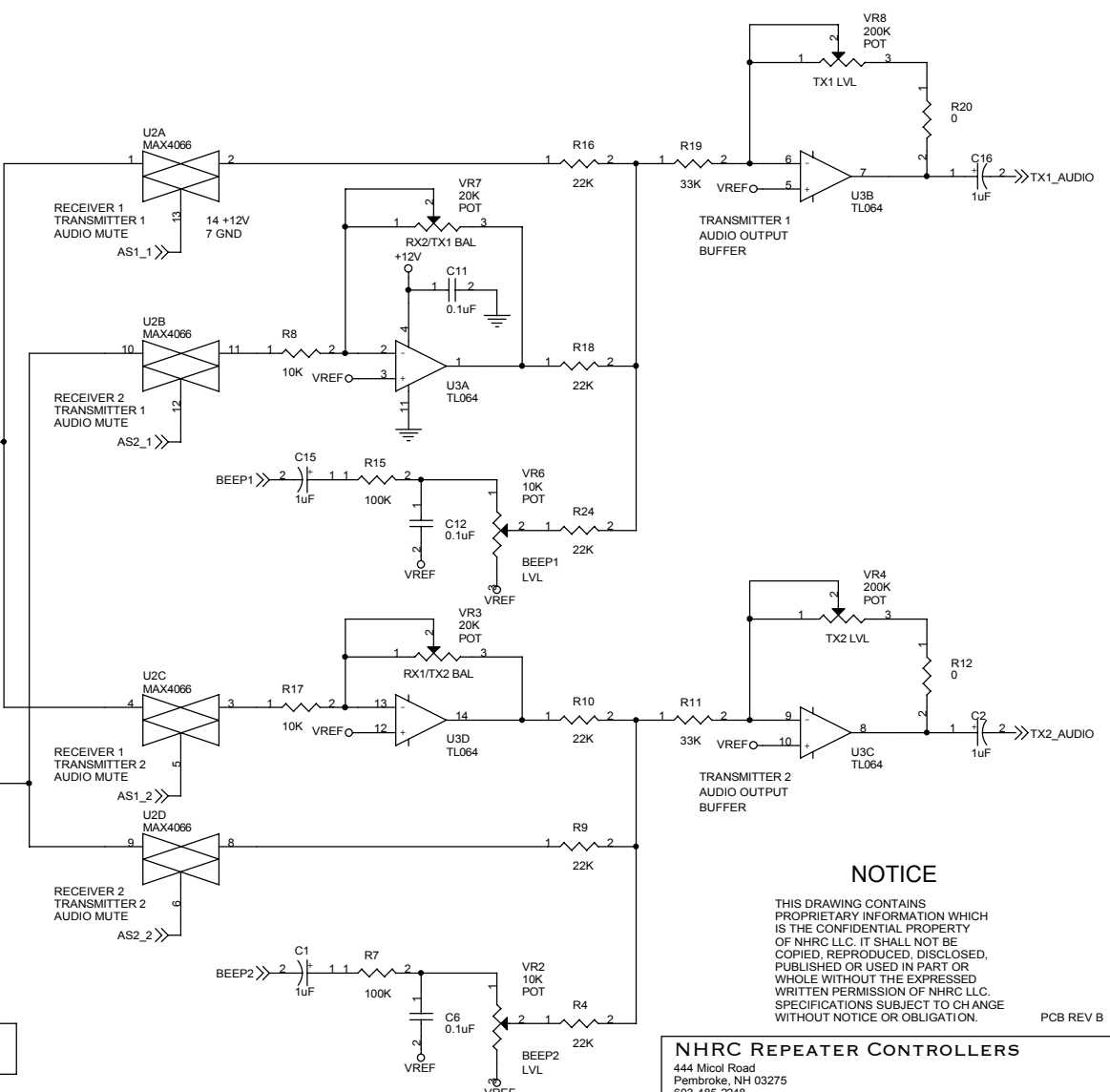
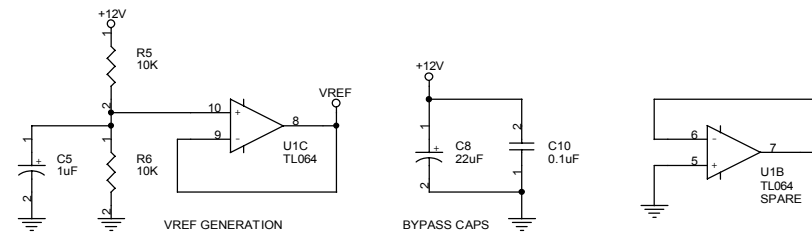
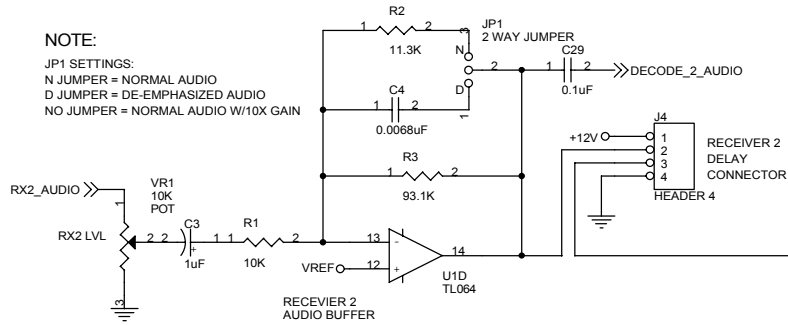
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Title NHRC-6 Repeater Controller (Interface)		
Size B	Document Number	Rev B
Date: Wednesday, August 21, 2002	Sheet 2	of 3

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
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Title NHRC-6 Repeater Controller (Audio)		
Size B	Document Number	Rev B
Date: Wednesday, August 21, 2002	Sheet 3	of 3

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9. Parts List

The following is the bill of materials for revision "B" of the NHRC-6 Repeater Controller.

NHRC-6 Repeater Controller Bill Of Materials

Revised: Wednesday, August 21, 2002
Revision: B

Item	Qty.	Ref.	Schematic Value	Description	Mfg.	Mfg. P/N	Notes
1	9	C1,C2,C3,C5,C13,C15,C16,C19,C23	1uF	16V Tantalum Cap	Panasonic	ECS-F1CE105K	
2	2	C14,C4	0.0068uF	50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA	
3	12	C6,C9,C10,C11,C12,C17,C18,C20,C21,C22,C26,C29	0.1uF	50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
4	1	C7	220uF	25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM221	
5	1	C8	22uF	25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
6	2	C24,C25	22pF	100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A220JCA	
7	1	C27	33pF	100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	
8	1	C28	33pF	100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	DNP
9	1	D1	1N4002	1A 100V Silicon Rectifier	Diodes Inc	1N4002	
10	3	D2,D3,D6	LED	Red T1¼ LED	Lite-On	LTL-4203	
11	4	D4,D5,D7,D8	LED	Green T1¼ LED	Lite-On	LTL-4233	
12	2	D10,D9	LED	Yellow T1¼ LED	Lite-On	LTL-4253	
13	1	F1	1/2 A	1.1A Polyswitch	Raychem	RUE110	
14	2	JP1,JP2	2 WAY JUMPER	3 Circuit Header, .100" Straight	Molex	22-03-2031	
15	2	JP3,JP4	JUMPER	2 Circuit Header, .100" Straight	Molex	22-03-2021	
16	2	J2,J1	CONNECTOR DB9F	DB9F Right Angle Connector 0.318" PCB mount	NorComp	182-009-212-531	
17	1	J3	POWER JACK	Coaxial Power Jack, Right Angle PCB mount	Switchcraft	RAPC712	
18	2	J4,J5	HEADER 4	4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041	
19	3	Q1,Q2,Q3	IRF510	N Channel HEXFET	IRF	IRF510	
20	4	Q4,Q5,Q6,Q7	2N3904	NPN Transistor	Fairchild	2N3904	
21	2	Q8,Q9	2N7000	N Channel MOSFET	Fairchild	2N7000	
22	1	RP1	10K	10K x 4 Isolated Resistor Pack	Bourns	4608X-102-103	
23	1	RP2	10K	10K x 8 Bussed Resistor Pack	Bourns	4609X-101-103	

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24	8	R1,R5,R6,R8,R17,R21,R27, R29	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K
25	1	RP3	470 x 9 Bussed Resistor Pack	Bourns	4610X-101-471
26	2	R22,R2	11.3K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 11K3
27	2	R3,R23	93.1K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 93K1
28	6	R4,R9,R10,R16,R18,R24	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K
29	6	R7,R15,R30,R31,R32,R33	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K
30	2	R11,R19	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K
31	2	R12,R20	Zero Ohm ¼W Jumper	Yaego	ZOR-25-B
32	3	R13,R14,R25	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R
33	2	R28,R26	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K
34	1	R34	1.2K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 1K2
35	2	U1,U3	Quad JFET Input Op-Amp	TI	TL064CN
36	1	U2	Quad SPST Analog Switch	Maxim	MAX4066
37	1	U4	5V 1.0A Voltage Regulator	Nat'l Semi	LM340T-5.0
38	1	U5	Microcontroller w/ 8K Flash Memory	Microchip	PIC16F876-20/SP
39	2	U6,U7	DTMF Decoder	Teltona	M-8870-01
40	4	VR1,VR2,VR5,VR6	POT 10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
41	2	VR7,VR3	POT 20K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B24
42	2	VR8,VR4	POT 200K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B25
43	1	Y1	16MHz Crystal	ECS	ECS-160-20-4
44	1	Y2	3.579545MHz Crystal	ECS	ECS-35-17-4
Additional Items					
45	1		NHRC-6 PCB rev B	NHRC	NHRC-6 PCB rev B
46	1		28 Pin DIP Socket	Mill-Max	110-99-328-41-001
47	2		18 Pin DIP Socket	Mill-Max	110-99-318-41-001
48	3		14 Pin DIP Socket	Mill-Max	110-99-314-41-001
49	2		4 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3047
50	8		Crimp Terminal for Molex Housing	Molex	08-50-0114
51	4		Shorting Jumpers	3M	929950-00-1

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.

NHRC
REPEATER CONTROLLERS