

NHRC

REPEATER CONTROLLERS

NHRC-7

User Guide

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Thank You!

Thank you for purchasing the NHRC-7 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-7 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-7 are:

- Two radio ports
- Can support the following configurations:
 - two duplex repeaters
 - duplex repeater with link radio
 - two back-to-back simplex radios
- Three DTMF decoders, one for each radio port, and one for the dedicated control receiver input.
- Unique courtesy tones to indicate selected receiver port.
- Saves five different configuration setups.
- Flexible CTCSS encoder control.
- Four digital inputs for alarm and telemetry use.
- Transmitter fan control output automatically runs fan while transmitting and for a programmable delay after.
- Up to four digital outputs for control applications.
- 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-7 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.

Each radio port has a dedicated DTMF decoder to allow the controller to be commanded over the radio inputs. In addition, a third DTMF decoder is provided for a control receiver. The controller can simultaneously receive and process DTMF commands from all three decoders.

The architecture of the NHRC-7 allows the controller to be used in a variety of different applications. These applications include simultaneous control of two repeaters, each with it’s 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.

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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.
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.

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-7 Repeater Controller into a repeater system.

2.1 *Input and Output Signal Levels.*

Control signals into the NHRC-7 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	CTCSS Encoder Control	Active Low
7	CAS	Active High
8	Ground	
9	Fan Control	Active Low

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	CTCSS Encoder Control	Active Low
7	CAS	Active High
8	Ground	
9	Ground	

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2.3.1 Use of the Fan Control Digital Output

The NHRC-7 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 3.6.1 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.

2.3.2 Use of the CTCSS Encoder Control Output

Each radio port on the NHRC-7 supports CTCSS Encoder Control. This feature allows the controller to enable and disable the radio's generated CTCSS encoder tone to allow flexible linking or to provide delayed PTT turn off to reduce squelch crashes in users' radios.

The NHRC-7 will pull the CTCSS Encoder Control pin to ground through an open collector when then controller wants to have CTCSS generated. Note that the CTCSS Encoder Control outputs are shared with the digital outputs, the encoder control for radio port 1 is digital output 1 and the encoder control for radio port 2 is digital output 2. See sections 4.1, 4.3 and 4.7 for information on configuring the controller to control CTCSS encoders through these outputs.

2.3.3 Receiver Equalization Jumpers

Each radio port on the NHRC-7 can support discriminator or de-emphasized audio. JP2 selects the equalization for radio port 1, and JP1 selects the equalization for radio port 2. Setting the jumper from the middle pin to the pin marked "D" will cause the controller to introduce a -6 dB/octave slope on the receiver audio, allowing the use of discriminator audio. Setting the jumper from the middle pin to the pin marked "N" will not process the audio, allowing the use of de-emphasized audio. Removing the jumper will cause the controller to not process the audio, and introduce a 10 dB boost in the receiver audio.

JP2 and JP1 Equalization Jumper Settings

Jumper	Equalization/Boost
D	-6 dB/Octave De-emphasis filter. For discriminator audio
N	No processing. For de-emphasized audio
(missing)	No processing. For de-emphasized audio. 10 dB boost.

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2.4 Delay Connectors

The NHRC-7 supports one or two optional NHRC-DADs, (CODEC digital audio delays), to reduce squelch crashes and fully mute DTMF tones.

Jacks “J7 RECEIVER 1 DELAY” and “J6 RECEIVER 2 DELAY” are provided on the controller to interface NHRC-DADs.

Jacks J7 and J6 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.

J7 RECEIVER 1 DELAY and J6 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.

2.5 Audio Level Adjustment

2.5.1 Overview:

Because of the variety of applications that the NHRC-7 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-7 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 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 J7 to the *optional* digital audio delay board for squelch tail elimination. If the digital audio delay is not present, J7 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 R18, 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 C16/R17/C12 network, has it’s level set with potentiometer VR7, and is supplied to transmitter 1’s mix bus through resistor R28. Transmitter 1’s master audio level is adjusted with potentiometer VR9.

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 J6 to the *optional* digital audio delay board for squelch tail elimination. If the digital audio delay is not present, J6 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 VR8 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 R1. Transmitter 1’s master audio level is adjusted with potentiometer VR4.

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 control receiver DTMF decoder input audio level.

VR6 sets the receiver 1 audio input level into the controller, and, more critically, into the DTMF decoder for receiver 1.

VR7 sets the beep level for transmitter 1.

VR8 is a “balance” control that sets the level of receiver 2 into transmitter 1.

VR9 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 VR6 (VR1) until the DTMF tones are reliably decoded, as indicated by LED D9 (D10). 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 VR9 (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 VR9 (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 VR7 (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. VR8 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.
9. To set the control receiver DTMF decoder input level, start with VR5 fully counter-clockwise. Send some DTMF tones on the control receiver input, and slowly increase VR5 until the tones are reliably decoded, as indicated by LED D11.

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2.6 The LED Indicators

The NHRC-7 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-7 LED Indicator Functions

Part	Label	Color	Indicates
D2	+12V	Red	Power
D3	TX1 PTT	Red	Radio 1 Transmit
D4	RX1 COR	Green	Radio 1 Unsquelched
D5	RX1 PL	Amber	Radio 1 CTCSS Detect
D6	TX2 PTT	Red	Radio 2 Transmit
D7	RX2 COR	Green	Radio 2 Unsquelched
D8	RX2 PL	Amber	Radio 2 CTCSS Detect
D9	DTMF 0 RX1	Yellow	Radio 1 DTMF Detect
D10	DTMF 1 RX2	Yellow	Radio 2 DTMF Detect
D11	DTMF 2 CTRL	Yellow	Radio 2 DTMF Detect

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

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2.7 Control Receiver Connector

The control receiver can be connected to the “J4 CTRL RX” jack. J4 is a 3.5 mm monophonic mini-phone jack.



3.5 mm mini-phone plug

J4 CTRL RX Connector Pin-out

Pin #	Use
Sleeve	Ground
Tip	Control Receiver Audio

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2.8 J5: 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-7 has an expansion connector to allow users to interface custom hardware to the controller. The expansion connector has 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.

J5 DIGITAL IO Expansion Connector

Pin	Signal	Description
1	+5 Volts	Regulated +5 Volts
2	EXP1	ALARM\ for alarm telemetry
3	EXP2	Courtesy Tone Select Input 1
4	EXP3	Courtesy Tone Select Input 2
5	EXP4	Courtesy Tone Select Input 3
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

All eight expansion pins are buffered to the microcontroller through 4.7K ohms. The input pins also have a 47K ohm pull up resistor.

2.8.1 ALARM\ Alarm Indicator

Input ALARM\ 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 at the interval specified by the alarm interval timer, until the alarm is reset. See section 4.7 for instructions to enable the alarm, and section 5.6 for the alarm clear command.

2.8.2 Courtesy Tone Selection

Inputs CTSEL1, CTSEL2 and CTSEL3 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 the controller has very weak (47K) pullup resistors to set the state of the pins when they are not connected to external circuitry. When the inputs are pulled to ground, different courtesy tones are selected, as shown below:

Courtesy Tone Selection			
CTSEL1	CTSEL2	CTSEL3	Courtesy Tone Selected
High	High	High	Controller's Normal Courtesy Tone
Low	High	High	Courtesy Tone 4
High	Low	High	Courtesy Tone 5
Low	Low	High	Courtesy Tone 5
High	High	Low	Courtesy Tone 6
Low	High	Low	Courtesy Tone 6
High	Low	Low	Courtesy Tone 6
Low	Low	Low	Courtesy Tone 6

Note that the controller uses priority to select which courtesy tone to use. CTSEL3 has the highest priority, and CTSEL1 has the lowest priority.

2.8.3 Digital Output Ports

Outputs OUT1, OUT2, OUT3, and OUT4 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.

2.8.3.1 CTCSS Encoder Control

Outputs OUT1 and OUT2 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. A small NPN transistor is provided on the controller board to provide active-low encoder control outputs on the DB9 radio connectors. 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. When CTCSS encoder mode is enabled, the digital output pin will be used for CTCSS control.

See sections 4.1, 4.3, and 4.7 for information on the CTCSS encoder control settings.

2.8.4 Power and Ground connections

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.

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-7.** After a short pause, the controller will transmit “NHRC 7” 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: *2 07 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.

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 send the CW message "NHRC 7".
- **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.

3.4 *1: Save Setup

The NHRC-7 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. To say that again, another way, when the controller powers up, saved setup #0 is loaded. If you want to set the power up state of the controller, set the control operator switches the way you want, then save state #0.

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.

3.5 *2: Program Command Prefixes

Every command accepted by the NHRC-7 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	Fan Control/Digital Output Control
03	03	Load Saved Setup
04	04	Link State Control
05	05	Digital Outputs 1-4 Control
06	06	Reset Alarm
07	07	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 7 (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”,

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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-7 has 9 timers that control various parameters of the repeaters.

Depending on the timer's application within the controller, the timer will have either 0.1, 1, 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.

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3.6.1 Program a timer

The NHRC-7 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-7 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	Alarm Alert Interval	10	60 seconds

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 31 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-7 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 0512 0515 0519 0522.

Courtesy Tone Uses

<u>Tone</u>	<u>Use</u>	<u>Default Value</u>
0	Receiver 1 into Transmitter 1 courtesy tone.	4 note rising trill
1	Receiver 1 into Transmitter 2 courtesy tone.	4 note rising trill
2	Receiver 2 into Transmitter 1 courtesy tone.	4 node falling trill
3	Receiver 2 into Transmitter 2 courtesy tone.	4 note falling trill
4	CTSEL1 low	CW letter 1
5	CTSEL2 low	CW letter 2
6	CTSEL3 low	CW letter 3
7	Controller unlocked courtesy tone	4 note high low high low

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 7” in CW.

4. Control Operator Commands

The NHRC-7 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.

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	Encode Tone TX1	When set (1), TX1’s CTCSS Encoder Control output will activate (go low) whenever receiver 1 is active.
5	Encode Tone TX2	When set (1), TX2’s CTCSS Encoder Control output will activate (go low) whenever receiver 1 is active.
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	Encode Tone TX1	When set (1), TX1’s CTCSS Encoder Control output will activate (go low) whenever receiver 2 is active.
5	Encode Tone TX2	When set (1), TX2’s CTCSS Encoder Control output will activate (go low) whenever receiver 2 is active.
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: Miscellaneous Control Settings

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	Alarm Input Enable	When set, causes digital input 1 to act as an alarm input. When digital input 1 is pulled to ground, then alarm will be triggered, and the alarm tone will be sent to all transmitters, on the interval defined by the alarm interval timer, until the alarm is reset. See sections 4.7 and 5.6.
4	Control Receiver Confirms to Transmitter 1	When set (1), causes command received on the control receiver to have their confirmation messages sent over transmitter 1.
5	Control Receiver Confirms to Transmitter 2	When set (1), causes command received on the control receiver to have their confirmation messages sent over transmitter 2.
6	CTCSS “Burst” control, transmitter 1	When set (1), causes the controller to disable the CTCSS encoder control output 250 milliseconds before dropping PTT for transmitter 1. This feature helps reduce squelch crashes in users’ radios.
7	CTCSS “Burst” control, transmitter 2	When set (1), causes the controller to disable the CTCSS encoder control output 250 milliseconds before dropping PTT for transmitter 2. This feature helps reduce squelch crashes in users’ radios.

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4.8 Group 7 Switches: Digital Outputs Control

The Group 7 switches are used to control the digital outputs on connector J5 of the NHRC-7.

Group 7 Switches:

<u>Switch</u>	<u>Action</u>	<u>Description</u>
0	Digital output 1 output control	When set (1), digital output 1 will be set to logic 1 state. When clear (0), digital output 1 will set to logic 0 state.
1	Digital output 2 output control	When set (1), digital output 2 will be set to logic 1 state. When clear (0), digital output 2 will be set to logic 0 state.
2	Digital output 3 output control	When set (1), digital output 3 will be set to logic 1 state. When clear (0), digital output 3 will be set to logic 0 state.
3	Digital output 4 output control	When set (1), digital output 4 will be set to logic 1 state. When clear (0), digital output 4 will be set to logic 0 state.
4	Digital output 1 pulsed mode.	When enabled (1), setting digital output 1 to on will cause it to remain on for ½ second, then be automatically turned off.
5	Digital output 2 pulsed mode.	When enabled (1), setting digital output 2 to on will cause it to remain on for ½ second, then be automatically turned off.
6	Digital output 3 pulsed mode.	When enabled (1), setting digital output 3 to on will cause it to remain on for ½ second, then be automatically turned off.
7	Digital output 4 pulsed mode.	When enabled (1), setting digital output 4 to on will cause it to remain on for ½ second, then be automatically turned off.

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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.

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-7 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), for receiver 1, and control operator Group 2, Item 5 to enabled (1) for receiver 2.. (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 still the default "01", the repeater can be activated by sending "01 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 "01 0".

5.2 Digital Output Control – Fan Control Output

The NHRC-7 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 still the default 02, if you want to turn the output off, you can send "020" to the controller. The controller will respond with “off” sent in CW. To test the state of the output you can send “02” 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-7 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 still set to the default 03, and you want to select your “net mode”, saved as setup #1, send “03 1”. The controller will respond with the CW message “OK”.

5.4 Link State Control

The NHRC-7 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 still set to the default "04".

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".

For back-to-back duplex radios, 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".

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

5.5 Digital Outputs Control

The four digital outputs on connector J5 can be controlled using this command. Each of the four outputs can be individually controlled. The outputs can be configured for pulsed operation, if desired. See section 4.8 for information on configuring the digital outputs for pulsed operation.

Note that OUT1 and OUT2 also serve as CTCSS encoder control outputs for port 1 and port2, respectively. Do not use these digital outputs if you are using CTCSS encoder control. Whatever you program for these outputs will be overridden by the CTCSS encode control, whenever it is enabled.

When an output is commanded to 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 outputs state.

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

<prefix><port><state> where:

- <prefix>** is the Digital Outputs Control prefix as programmed by the repeater operator
- <port>** Is the number of the digital output port you want to control, 1, 2, 3, or 4 for OUT1, OUT2, OUT3, of OUT4.
- <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 Outputs Control prefix is still the default 05, if you want to turn digital output 2 off, you can send "0520" to the controller. The controller will respond with “off” sent in CW. To test the state of that output you can send “052” to the controller; the controller will respond with either “on” or “off”, depending on the state of the output.

5.6 Reset Alarm

If the NHRC-7's alarm has been tripped, it can be reset with this command.

To reset the alarm, enter the following command:

<prefix> where:

<prefix> is the Reset Alarm prefix as programmed by the repeater operator

Example: Assuming the Reset Alarm prefix is still the default 06, send "06" to the controller. The controller will respond with "OK" in CW to indicate the command was accepted.

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5.7 Unlock Controller

The NHRC-7 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.

Do not leave the unlock code set to the default 07.

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	Digital Outputs Control	05
06	Reset Alarm	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, 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	Alarm Tone Interval	10	6	60

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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 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	Enable CTCSS Encoder, Transmitter 1	0	
0	5	Enable CTCSS Encoder, Transmitter 2	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	Enable CTCSS Encoder, Transmitter 1	0	
2	5	Enable CTCSS Encoder, Transmitter 2	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: Miscellaneous Control Settings

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	Alarm Input Enable	0	
6	4	Enable Control Receiver Confirmation to Transmitter 1	0	
6	5	Enable Control Receiver Confirmation to Transmitter 2	0	
6	6	Enable CTCSS Encoder“Burst”, Transmitter 1	0	
6	7	Enable CTCSS Encoder“Burst”, Transmitter 2	0	

6.2.8 Control Operator Group 7 Switches: Digital Outputs Control

Group #	Item #	Function	Default	Comments
7	0	Digital Output 1 Control	0	
7	1	Digital Output 2 Control	0	
7	2	Digital Output 3 Control	0	
7	3	Digital Output 4 Control	0	
7	4	Digital Output 1 pulsed mode	0	
7	5	Digital Output 1 pulsed mode	0	
7	6	Digital Output 1 pulsed mode	0	
7	7	Digital Output 1 pulsed mode	0	

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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	NHRC Test Mode.	0	Port test enable. 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.

7. Programming Examples

This section of the manual includes some example programming “recipes” that can be used as examples, or as a basis for your programming your controller. NHRC suggests that you read and understand the manual prior to putting the controller into service, however, these examples can be used to get started with the controller.

7.1 *Back-to-back transceivers*

In this example, the system operator wants to use a NHRC-7 to link two transceivers back-to-back to form an inter-system link. The unlock code will be set to 236, the CW IDs disabled, timeout timers set to 3 minutes.

Procedure:

Install INIT jumper JP3 and power the controller on. Do not remove the jumper. This will reset the controller to the factory defaults.

Send DTMF “07” to unlock the controller. The controller should send “OK”.

Send *207236 to change the unlock code to 236. The controller should send “OK”.

Remove INIT jumper JP3. The jumper was present to initialize the controller on power up, and also because it is required to change the unlock code. It must be removed now, so the controller does not reset on the next power up.

Send *305180 to set timer 05 (the long timeout timer) to 180 seconds. The controller should send “OK”.

Send *0430 to disable the CW ID on transmitter 1. This uses the “unlocked mode control operator access” feature. The controller should send “OFF”.

Send *0530 to disable the CW ID on transmitter 2. The controller should send “OFF”.

Send *0060 to disable receiver 1 to transmitter 1 routing. The controller should send “OFF”.

Send *0071 to enable receiver 1 to transmitter 2 routing. The controller should send “ON”.

Send *0261 to enable receiver 2 to transmitter 1 routing. The controller should send “ON”.

Send *0270 to disable receiver 2 to transmitter 2 routing. The controller should send “OFF”.

Send *10 to save the power up defaults. The controller should send “OK”.

Send “#” to lock the controller. The controller should send “OK”.

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7.2 Back-to-back Repeaters.

In this example, the NHRC-7 is used to control two repeaters that can be linked back-to-back, but normally are not. The Unlock code will be set to 236. The repeater on port 1 will have KA1AAA for its ID and will use a timeout timer of 45 seconds. The repeater on port 2 will have WZ9ZZZ for its ID and will use a timeout timer of 60 seconds. The Link State Control prefix will be set to 321, and the controller will be set to have the repeaters NOT LINKED in normal mode.

Procedure:

Install INIT jumper JP3 and power the controller on. Do not remove the jumper. This will reset the controller to the factory defaults.

Send DTMF "07" to unlock the controller. The controller should send "OK".

Send *207236 to change the unlock code to 236. The controller should send "OK".

Remove INIT jumper JP3. The jumper was present to initialize the controller on power up, and also because it is required to change the unlock code. It must be removed now, so the controller does not reset on the next power up.

Send *700 52 21 01 21 21 21 to program ID 1 as KA1AAA. The controller should send "OK".

Send *701 91 93 09 93 93 93 to program ID 2 as WZ9ZZZ. The controller should send "OK".

Send *0451 to enable duplex operation on port 1. The controller should send "ON".

Send *0541 to enable duplex operation on port 2. The controller should send "ON".

Send *30560 to set timer 05 (the long timeout timer) to 60 seconds. The controller should send "OK".

Send *30660 to set timer 06 (the short timeout timer) to 45 seconds. The controller should send "OK".

Send *0120 to select the short timeout timer for receiver 1. The controller should send "Off".

Send *0541 to select CW ID 2 for transmitter 2. The controller should send "ON".

Send *204321 to change the Link State Control prefix to 321.

Send *10 to save the power up defaults. The controller should send "OK".

Send "#" to lock the controller. The controller should send "OK".

The controller is now programmed.

To bridge or link the two repeaters, send 32133. The controller should send "OK".

To unlink the two repeaters, send 32112. The controller should send "OK".

8. Circuit Board

8.1 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	“CTRL RX”	Input for control receiver audio
J5	“DIGITAL I/O”	Digital I/O for control and telemetry
J6	“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.
J7	“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.

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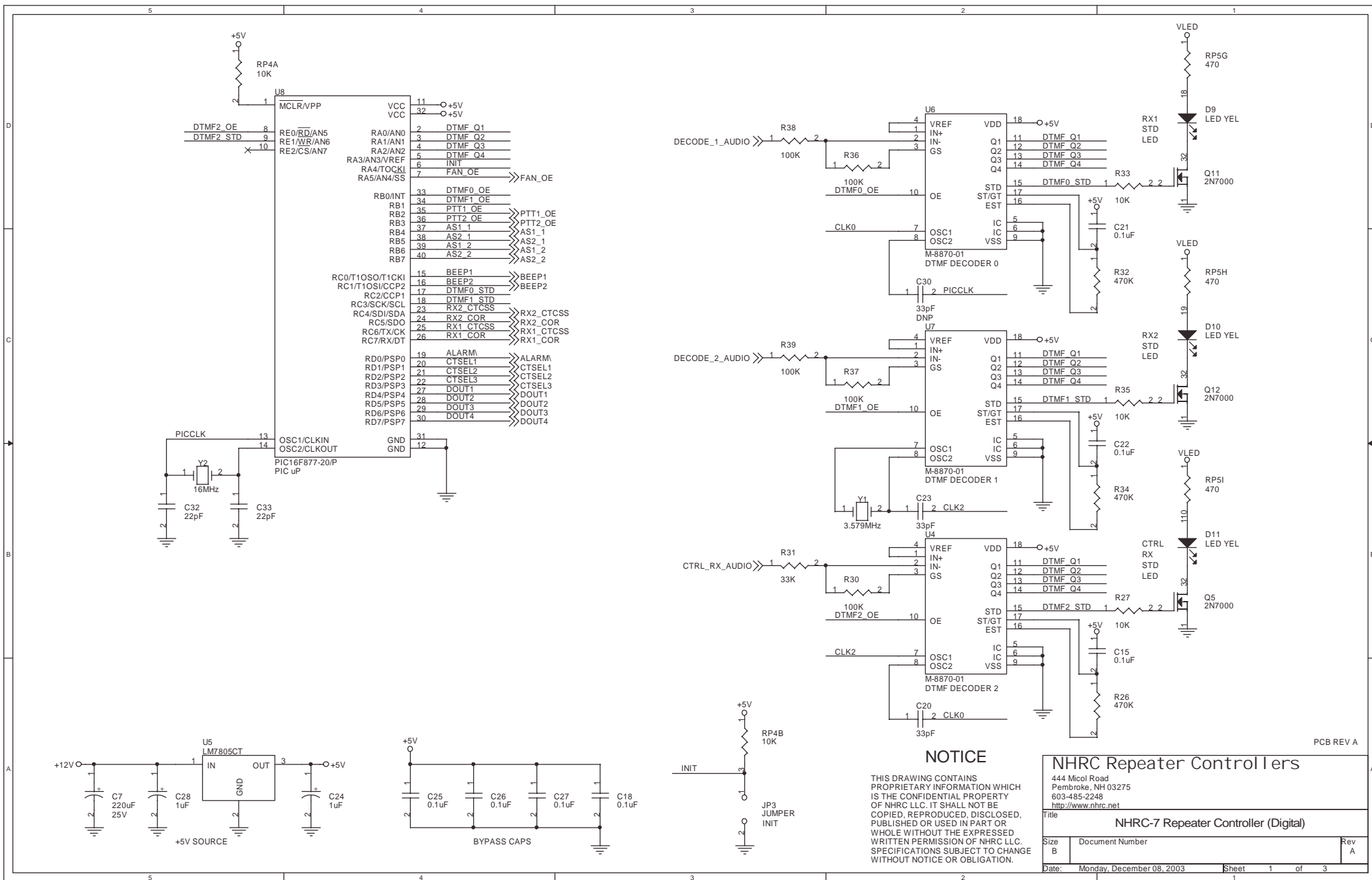
8.2 Jumpers

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-7 connectors and controls.

9. Schematics

The following three pages are the schematic diagram for Revision A of the NHRC-7 Repeater Controller.



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PCB REV A

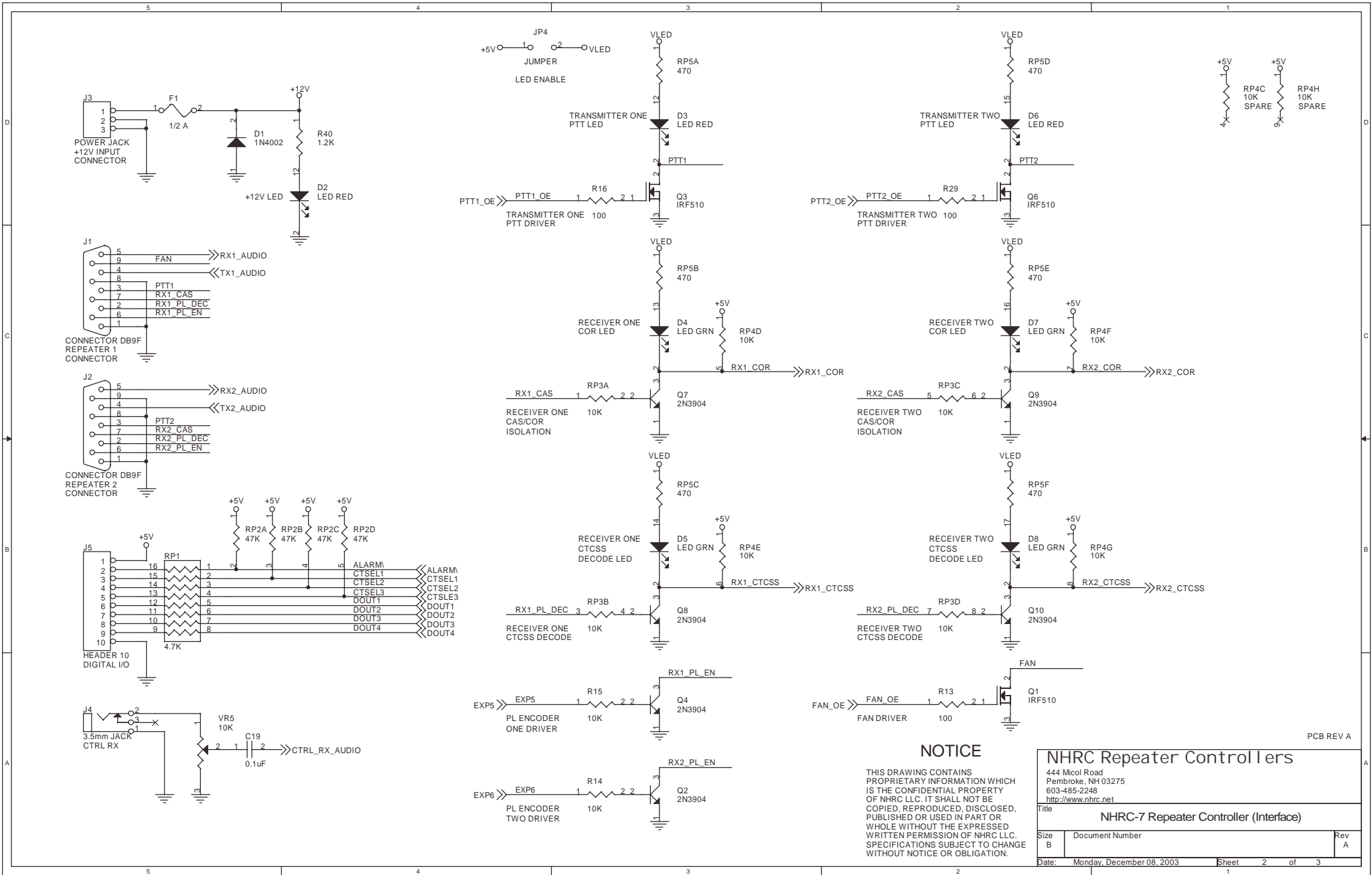
NHRC Repeater Controllers

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

Title: **NHRC-7 Repeater Controller (Digital)**

Size B	Document Number	Rev A
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Date: Monday, December 08, 2003 Sheet 1 of 3



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NHRC Repeater Controllers

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Title

NHRC-7 Repeater Controller (Interface)

Size

B

Document Number

Rev

A

Date:

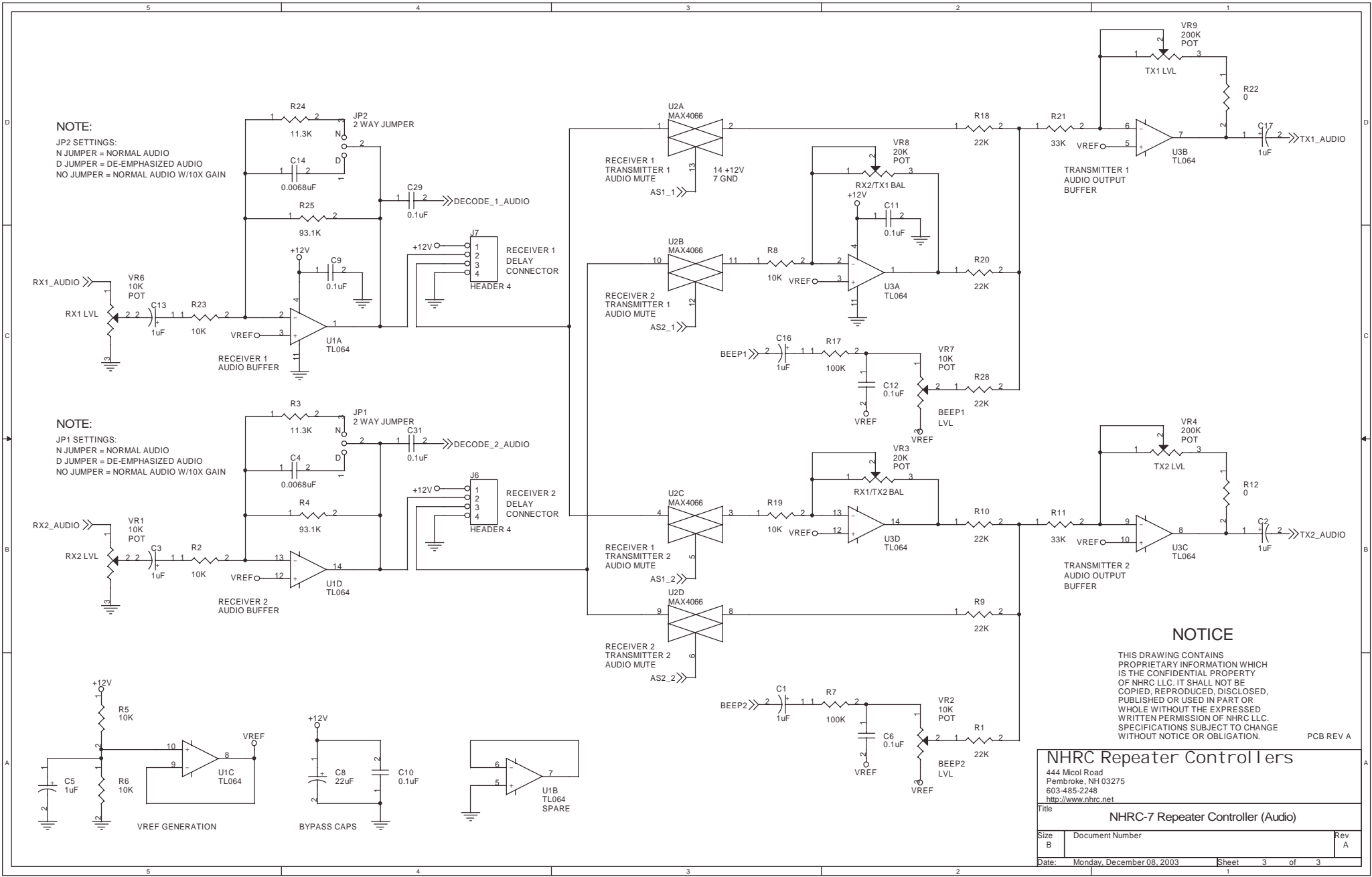
Monday, December 08, 2003

Sheet

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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

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NHRC-7 Repeater Controller (Audio)

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10. Parts List

The following is the bill of materials for revision "B" of the NHRC-7 Repeater Controller.

NHRC-7 Repeater Controller

Bill Of Materials

Revised: Wednesday, March 12, 2003

Revision: A

Item	Qty	Ref	Schematic Value	Description	Mfg.	Mfg. P/N	Notes
1	9	C1,C2,C3,C5,C13,C16,C17, C24,C28	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
2	2	C14,C4	0.0068uF	0.0068uF 50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA	
3	15	C6,C9,C10,C11,C12,C15, C18,C19,C21,C22,C25,C26, C27,C29,C31	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
4	1	C7	220uF	220uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM221	
5	1	C8	22uF	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
6	3	C23,C20,C30	33pF	33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	C30 DNP
7	2	C32,C33	22pF	22pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A220JCA	
8	1	D1	1N4002	1A 100V Silicon Rectifier	Diodes Inc	1N4002	
9	3	D2,D3,D6	LED RED	Red T1¾ LED	Lite-On	LTL-4203	
10	4	D4,D5,D7,D8	LED GRN	Green T1¾ LED	Lite-On	LTL-4233	
11	3	D9,D10,D11	LED YEL	Yellow T1¾ LED	Lite-On	LTL-4253	
12	1	F1	1/2 A	1.1A Polyswitch	Raychem	RUE110	
13	2	JP1,JP2	2 WAY JUMPER	3 Circuit Header, .100" Straight	Molex	22-03-2031	
14	2	JP4,JP3	JUMPER	2 Circuit Header, .100" Straight	Molex	22-03-2021	
15	2	J2,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	1	J4	3.5mm JACK	3.5mm 2 Circuit Right Angle Jack, PCB mt.	Cui-Stack	MJ-3536	
18	1	J5	HEADER 10	10 Circuit Header, .100" Right Angle w/ lock	Molex	22-05-3101	
19	2	J6,J7	HEADER 4	4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041	
20	3	Q1,Q3,Q6	IRF510	N Channel HEXFET	IRF	IRF510	
21	6	Q2,Q4,Q7,Q8,Q9,Q10	2N3904	NPN Transistor	Fairchild	2N3904	

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22	3	Q5,Q11,Q12	2N7000	N Channel MOSFET	Fairchild	2N7000
23	1	RP1	4.7K	4.7K x 8 Isolated Resistor Pack	Bourns	4116R-001-472
24	1	RP2	47K	47K x 4 Bussed Resistor Pack	Bourns	4605X-101-473
25	1	RP3	10K	10K x 4 Isolated Resistor Pack	Bourns	4608X-102-103
26	1	RP4	10K	10K x 8 Bussed Resistor Pack	Bourns	4609X-101-103
27	1	RP5	470	470 x 9 Bussed Resistor Pack	Bourns	4610X-101-471
28	6	R1,R9,R10,R18,R20,R28	22K	22K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 22K
29	11	R2,R5,R6,R8,R14,R15,R19, R23,R27,R33,R35	10K	10K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 10K
30	2	R24,R3	11.3K	11.3K ¼W 1% Metal Film Resistor	Yageo	MFR-25FBB 11K3
31	2	R4,R25	93.1K	93.1K ¼W 1% Metal Film Resistor	Yageo	MFR-25FBB 93K1
32	7	R7,R17,R30,R36,R37,R38, R39	100K	100K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 100K
33	3	R11,R21,R31	33K	33K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 33K
34	2	R12,R22	0	Zero Ohm ¼W Jumper	Yageo	ZOR-25-B
35	3	R13,R16,R29	100	100 ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 100R
36	3	R26,R32,R34	470K	470K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 470K
37	1	R40	1.2K	1.2K ¼W 5% Carbon Film Resistor	Yageo	CFR-25JB 1K2
38	2	U1,U3	TL064	Quad JFET Input Op-Amp	TI	TL064CN
39	1	U2	MAX4066	Quad SPST Analog Switch	Maxim	MAX4066CPD
40	3	U4,U6,U7	M-8870-01	DTMF Decoder	Zarlink	MT8870DE
41	1	U5	LM7805CT	5V 1.0A Voltage Regulator	Nat'l Semi	LM340T-5.0
42	1	U8	PIC16F877-20/P	Microcontroller w/ 8K Flash Memory	Microchip	PIC16F877-20/P
43	5	VR1,VR2,VR5,VR6,VR7	10K POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14
44	2	VR8,VR3	20K POT	20K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B24
45	2	VR9,VR4	200K POT	200K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B25
46	1	Y1	3.579MHz	3.579545MHz Crystal	ECS	ECS-35-17-4
47	1	Y2	16MHz	16MHz Crystal	ECS	ECS-160-20-4
Additional Items						
48	1			NHRC-7 PCB	NHRC	NHRC-7 PCB rev A
49	1			40 Pin DIP Socket	Mill-Max	110-99-640-41-001
50	3			18 Pin DIP Socket	Mill-Max	110-99-318-41-001
51	3			14 Pin DIP Socket	Mill-Max	110-99-314-41-001
52	2			4 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3047

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53	1	10 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3107
54	18	Crimp Terminal for Molex Housing	Molex	08-50-0114
55	6	Shorting Jumpers	3M	929950-00-I

11. 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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