

# **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 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.

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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 unscelched) 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.

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## 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.

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### ***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
<b>Sleeve</b>	<b>“Outer Barrel”</b>	<b>Ground</b>
<b>Tip</b>	<b>“Inner Connector”</b>	<b>+12 (13.8)</b>

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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 or Low
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 or Low
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 3.6.2 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 group 2 switch 5 can then be used to turn the output on or 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 the 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 section 2.8.4.1 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**

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

## 2.3.4 Receiver CAS Polarity Jumpers

Each radio port on the NHRC-7 can support either an active high or active low CAS input. JP5 selects the CAS Polarity for radio port 1, and JP6 selects the CAS Polarity for radio port 2. Setting the jumper from the middle pin to the pin marked "H" will set the controller to accept an active high CAS input. Setting the jumper from the middle pin to the pin marked "L" will set the controller to accept an active low CAS input. Removing the jumper will cause the controller to not process the CAS input.

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## JP5 and JP6 CAS Polarity Jumper Settings

<b>Jumper</b>	<b>CAS Polarity</b>
<b>H</b>	<b>Active High CAS Polarity</b>
<b>L</b>	<b>Active Low CAS Polarity</b>

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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.

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## 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 its 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 its 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.



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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 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 2<sup>nd</sup> 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
<b>D2</b>	<b>+12V</b>	<b>Red</b>	<b>Power</b>
<b>D3</b>	<b>TX1 PTT</b>	<b>Red</b>	<b>Radio 1 Transmit</b>
<b>D4</b>	<b>RX1 COR</b>	<b>Green</b>	<b>Radio 1 Unsilenced</b>
<b>D5</b>	<b>RX1 PL</b>	<b>Amber</b>	<b>Radio 1 CTCSS Detect</b>
<b>D6</b>	<b>TX2 PTT</b>	<b>Red</b>	<b>Radio 2 Transmit</b>
<b>D7</b>	<b>RX2 COR</b>	<b>Green</b>	<b>Radio 2 Unsilenced</b>
<b>D8</b>	<b>RX2 PL</b>	<b>Amber</b>	<b>Radio 2 CTCSS Detect</b>
<b>D9</b>	<b>DTMF 0 RX1</b>	<b>Yellow</b>	<b>Radio 1 DTMF Detect</b>
<b>D10</b>	<b>DTMF 1 RX2</b>	<b>Yellow</b>	<b>Radio 2 DTMF Detect</b>
<b>D11</b>	<b>DTMF 2 CTRL</b>	<b>Yellow</b>	<b>Radio 2 DTMF Detect</b>

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
<b>Sleeve</b>	<b>Ground</b>
<b>Tip</b>	<b>Control Receiver Audio</b>

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## 2.8 J6: Digital I/O Expansion Connector

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

The NHRC-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 EXP1 serves as an alarm indicator. This input is active low, and should be pulled to ground by an external device to indicate a site alarm function. Once the alarm is tripped, an alert tone will play over the repeater's transmitter every 1 minute, until the alarm is reset. See section 4.7 for instructions to enable the alarm, and section 5.6 for the alarm clear command.

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## 2.8.2 Courtesy Tone Selection

Inputs EXP2, EXP3 and EXP4 can be used to select alternate courtesy tones to indicate alarm status, voted receiver status, etc. These pins are configured as inputs to the microcontroller, and the controller has 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**

EXP2	EXP3	EXP4	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. EXP has the highest priority, and EXP2 has the lowest priority.

Courtesy Tones can also be selected based on the last saved state number loaded. This is useful to telemeter the current operating mode of the controller, especially when used together with the saved state selection, described below. Group 3, switch 5 controls this setting. See section 4.4 for more information.

## 2.8.3 Saved State Selection

Digital inputs EXP2, EXP3, and EXP4 can also be used to load a saved state into the controller. This allows external logic to effect changes to the operational state of the controller, for instance, an external set of pushbuttons could be used to link and unlink a remote base.

This mode is configured by setting control operator group 1, switch 5 to enabled (1). See section 4.2 for more information about setting this mode.

These inputs are falling-edge triggered active low inputs. If more than one input is low, the lower numbered input is used to select the saved state.

## 2.8.4 Digital Output Ports

Outputs EXP5, EXP6, EXP7, and EXP8 are active high outputs, that are used as digital outputs 1 through 4. The outputs are protected with a 4700 ohm resistor in series, however, high voltage on these pins will destroy the microprocessor. These outputs must be buffered through power transistors, FETs, or solid-state relays. The state of these digital outputs can be stored in a saved setup.

### 2.8.4.1 CTCSS Encoder Control

Outputs EXP5 and EXP6 can be used to control the main and link transmitters CTCSS encoders, respectively. These outputs will provide an active-high signal when the CTCSS encoder should generate tone. A small NPN transistor is provided on the controller board to provide active-low

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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.

See section 4.7 for information on the CTCSS encoder control settings.

## **2.8.5 Power and Ground connectors**

Pin 1 provided regulated 5 volts for your interface circuitry, i.e. to provide +5 VDC to the pullup resistors used for the courtesy tone selection inputs. This power source should not be used to power external loads under any circumstances. Pin 10 provides a ground return for your external expansion logic circuits. This ground source should not be used as the return for any external loads controlled by the controller.

## 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.

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### 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 sent 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

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### 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.

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### 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-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	<b>Control Operator</b>
01	01	<b>DTMF Access</b>
02	02	<b>Fan Control/Digital Output Control</b>
03	03	<b>Load Saved Setup</b>
04	04	<b>Link State Control</b>
05	05	<b>Digital Outputs 1-4 Control</b>
06	06	<b>Reset Alarm</b>
07	07	<b>Unlock Controller</b>

**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”, then when a user sends

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“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-7 has 15 timers that control various parameters of the repeaters.

Depending on the timer's application within the controller, the timer will have either .01, 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.

### 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 specifies the amount of time between alarm tone transmissions when the alarm has been activated. This timer uses 10 second resolution.

Timer 09 (courtesy tone front porch delay, transmitter 1) and timer 10 (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. These timers have a .01 second resolution.

Timer 11 (transmitter 1 CW pitch) and Timer 13 (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.

Timer 12 (transmitter 1 CW speed) and Timer 14 (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.)

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## 3.6.2 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

<u>Timer No.</u>	<u>Description</u>	<u>Timer Resolution</u>	<u>Default Value</u>
00	Hang Timer Long	.1	10.0 seconds
01	Hang Timer Short	.1	5.0 seconds
02	ID Timer, 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
09	Transmitter 1 Courtesy Tone "front porch" timer	.01	.5 seconds
10	Transmitter 2 Courtesy Tone "front porch" timer	.01	.5 seconds
11	Transmitter 1 CW pitch	0-31	20 (C6)
12	Transmitter 1 CW speed	5-30	20 WPM
13	Transmitter 2 CW pitch	0-31	20 (C6)
14	Transmitter 2 CW speed	5-30	20 WPM

#### ***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.



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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.

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### 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-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>
0	<b>Receiver 1 into Transmitter 1 courtesy tone.</b>
1	<b>Receiver 1 into Transmitter 2 courtesy tone.</b>
2	<b>Receiver 2 into Transmitter 1 courtesy tone.</b>
3	<b>Receiver 2 into Transmitter 2 courtesy tone.</b>
4	<b>Digital Input 1 active (low)</b>
5	<b>Digital Input 2 active (low)</b>
6	<b>Digital Input 3 active (low)</b>
7	<b>Controller unlocked courtesy tone</b>

## 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.

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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	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	Load Saved State on EXP2, EXP3, EXP4 low	When enabled (1), a digital low on any of the EXP2 will load saved state 1, a digital low on EXP3 will load saved state 2, and a digital low on EXP4 will load saved state 3. If more than one of the inputs is low, the lowest numbered one is used.
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	Receiver 1 has priority	When enabled (1), receiver 1 activity will disable receiver 2. If enabled, and "receiver 2 has priority" is also enabled, then the first active receiver has priority. Note that this is regardless of link state – use with caution.
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	Saved State Number is Courtesy Tone Number	When enabled (1), the courtesy tone is selected based on the last saved state number loaded. Saved state 0 will use courtesy tone 0, saved state 1 will select courtesy tone 1, etc.
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	Receiver 2 has priority	When enabled (1), receiver 2 activity will disable receiver 1. If enabled, and "receiver 1 has priority" is also enabled, then the first active receiver has priority. Note that this is regardless of link state – use with caution.
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	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 2.8.1 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 Output Controls

The Group 7 switches control the state of the digital outputs on the Digital IO Expansion Connector. See Section 2.8 for more information about this connector.

### 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:**

<b><u>Switch</u></b>	<b><u>Name</u></b>	<b><u>Description</u></b>
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-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 "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-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 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-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 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-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**

<b>Routing-digit</b>	<b>Destination(s)</b>
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 Digital Outputs Control

The NHRC-7 digital outputs (on connector J5) can be controlled using this command. Each of the four outputs can be individually controlled.

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.
- <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 23, if you want to turn digital output 2 off, you can send "2320" to the controller. The controller will respond with “off” sent in CW. To test the state of that output you can send “232” to the controller; the controller will respond with either “on” or “off”, depending on the state of the output.

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## 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

<p><b><i>Example:</i></b> Assuming the Reset Alarm prefix is 1234, send “1234” to the controller. The controller will respond with “OK” in CW to indicate the command was accepted.</p>
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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.

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To unlock the controller: send the unlock code, release PTT, then listen for the special “controller unlocked” courtesy tone. The default unlock code is 07, 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	<b>Control Operator</b>	<b>00</b>
01	<b>DTMF Access</b>	<b>01</b>
02	<b>Digital Output Control</b>	<b>02</b>
03	<b>Load Saved Setup</b>	<b>03</b>
04	<b>Link State Control</b>	<b>04</b>
05	<b>Digital Outputs Control</b>	<b>05</b>
06	<b>Reset Alarm</b>	<b>06</b>
07	<b>Unlock Controller</b>	<b>07</b>



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## 6.1.2 Timer Defaults Table

Timer Number	Description	Multiplier	Timer Value	Effective Value
00	<b>Hang Timer Long</b>	<b>.1</b>	<b>100</b>	<b>10.0</b>
01	<b>Hang Timer Short</b>	<b>.1</b>	<b>50</b>	<b>5.0</b>
02	<b>ID Timer, Transmitter 1</b>	<b>10</b>	<b>54</b>	<b>540</b>
03	<b>ID Timer, Transmitter 2</b>	<b>10</b>	<b>54</b>	<b>540</b>
04	<b>DTMF Access Timer</b>	<b>10</b>	<b>60</b>	<b>600</b>
05	<b>Time-Out Timer Long</b>	<b>1</b>	<b>180</b>	<b>180</b>
06	<b>Time-Out Timer Short</b>	<b>1</b>	<b>30</b>	<b>30</b>
07	<b>Fan Timer</b>	<b>10</b>	<b>12</b>	<b>120</b>
08	<b>Alarm Tone Interval</b>	<b>10</b>	<b>6</b>	<b>60</b>
09	<b>Transmitter 1 Courtesy Tone “front porch” timer</b>	<b>.01</b>	<b>50</b>	<b>.5</b>
10	<b>Transmitter 2 Courtesy Tone “front porch” timer</b>	<b>.01</b>	<b>50</b>	<b>.5</b>
11	<b>Transmitter 1 CW pitch</b>	<b>N/Aa</b>	<b>20</b>	<b>C6 tone</b>
12	<b>Transmitter 1 CW speed</b>	<b>1</b>	<b>20</b>	<b>20 WPM</b>
13	<b>Transmitter 2 CW pitch</b>	<b>N/A</b>	<b>20</b>	<b>C6 tone</b>
14	<b>Transmitter 2 CW speed</b>	<b>1</b>	<b>20</b>	<b>20 WPM</b>

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## 6.1.3 Courtesy Tone Tones Table

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

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## 6.1.4 CW (“Morse Code”) Character Table

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

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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	Load Saved State on EXP2, EXP3, EXP4 low	0	When enabled (1), a digital low on any of the EXP2/3/4 inputs will load saved state 1, 2, or 3, respectively. If more than one of the inputs is low, the lowest numbered one is used.
1	4	Audio Delay Present	0	Set to 1 if audio delay is present on this receiver port.
1	5	Receiver 1 has priority	0	Set to 1 to mute receiver 2 when receiver 1 is active. If both receivers are set to have priority, the first active gets priority..
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	<b>Receiver Enable</b>	<b>1</b>	
2	1	<b>CTCSS Required</b>	<b>0</b>	
2	2	<b>Dual Squelch Enable</b>	<b>0</b>	
2	3	<b>DTMF Access Mode Enable</b>	<b>0</b>	See sections 5.1 and 3.5
2	4	<b>Enable CTCSS Encoder, Transmitter 1</b>	<b>0</b>	
2	5	<b>Enable CTCSS Encoder, Transmitter 2</b>	<b>0</b>	
2	6	<b>Receiver 2 to Transmitter 1 enable</b>	<b>0</b>	
2	7	<b>Receiver 2 to Transmitter 2 enable</b>	<b>1</b>	

### 6.2.4 Control Operator Group 3 Switches: Receiver 2 Control

Group #	Item #	Function	Default	Comments
3	0	<b>Key Up Delay (“kerchunker filter”)</b>	<b>0</b>	
3	1	<b>Receiver Time-Out Timer Enable</b>	<b>1</b>	See section 3.6
3	2	<b>Long Time Out Timer Select</b>	<b>1</b>	<b>1 = long, 2=short, See section 3.6</b>
3	3	<b>Saved State Number is Courtesy Tone Number</b>	<b>0</b>	<b>When enabled (1), the courtesy tone is selected based on the last saved state number loaded. Saved state 0 will use courtesy tone 0, saved state 1 will select courtesy tone 1, etc.</b>
3	4	<b>Audio Delay Present</b>	<b>0</b>	<b>Set to 1 if audio delay is present on this receiver port.</b>
3	5	<b>Receiver 2 has priority</b>	<b>0</b>	<b>Set to 1 to mute receiver 1 when receiver 2 is active. If both receivers are set to have priority, the first active gets priority..</b>
3	6	<b>Mute DTMF into Transmitter 1</b>	<b>1</b>	
3	7	<b>Mute DTMF into Transmitter2</b>	<b>1</b>	

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### 6.2.5 Control Operator Group 4 Switches: Transmitter 1 Control

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

### 6.2.6 Control Operator Group 5 Switches: Transmitter 2 Control

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

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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	Alarm Input Enable	0	
6	4	Enable Control Receiver Confirmation to Transmitter 1	0	
6	4	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	Reserved for NHRC

### 6.2.8 Control Operator Group 7 Switches: Digital Output Controls Operations Table

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
<b>8*</b>	0	<b>Write Protect Control Group Setups</b>	<b>0</b>	
<b>8*</b>	1	<b>Write Protect Prefixes</b>	<b>0</b>	
<b>8*</b>	2	<b>Write Protect Timers</b>	<b>0</b>	
<b>8*</b>	3	<b>Reserved</b>	<b>0</b>	<b>Reserved for NHRC</b>
<b>8*</b>	4	<b>Reserved</b>	<b>0</b>	<b>Reserved for NHRC</b>
<b>8*</b>	5	<b>Reserved</b>	<b>0</b>	<b>Reserved for NHRC</b>
<b>8*</b>	6	<b>Write Protect CW Messages &amp; Courtesy Tones</b>	<b>0</b>	
<b>8*</b>	7	<b>Reserved</b>	<b>0</b>	<b>Reserved for NHRC</b>

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

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

\* Controller must be unlocked to access Groups 8 and 9



# NHRC-7 User Guide

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## 6.3 Terminology and Abbreviations

<b><u>Term</u></b>	<b><u>Description</u></b>
<b>CAS</b>	Carrier Activated Squelch, where receipt of a signal, with or without CTCSS will activate the controller.
<b>CW</b>	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.
<b>Digital Audio Delay (DAD)</b>	Digital Audio Delay (DAD) removes squelch crashes and allows DTMF tones to be fully muted.
<b>DTMF</b>	Also known as “Touch Tone®” codes.
<b>Dual Squelch</b>	“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.
<b>ID</b>	Identification.
<b>PTT</b>	Push-to-Talk.
<b>Unlock Code</b>	A special password used to enable programming of the controller.

# NHRC-7 User Guide

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## 7. Circuit Board

### 7.1 Interconnections

Connector	Name	Purpose
<b>J1</b>	“REPEATER 1”	Connects repeater 1 transmit and receive audio, PTT, CAS, fan control to the controller
<b>J2</b>	“REPEATER 2”	Connects repeater 2 transmit and receive audio, PTT, and CAS to the controller
<b>J3</b>	Power	Supplies DC power to the controller
<b>J4</b>	“CTRL RX”	Input for control receiver audio
<b>J5</b>	“DIGITAL I/O”	Digital I/O for control and telemetry
<b>J6</b>	“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.
<b>J7</b>	“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.

# NHRC-7 User Guide

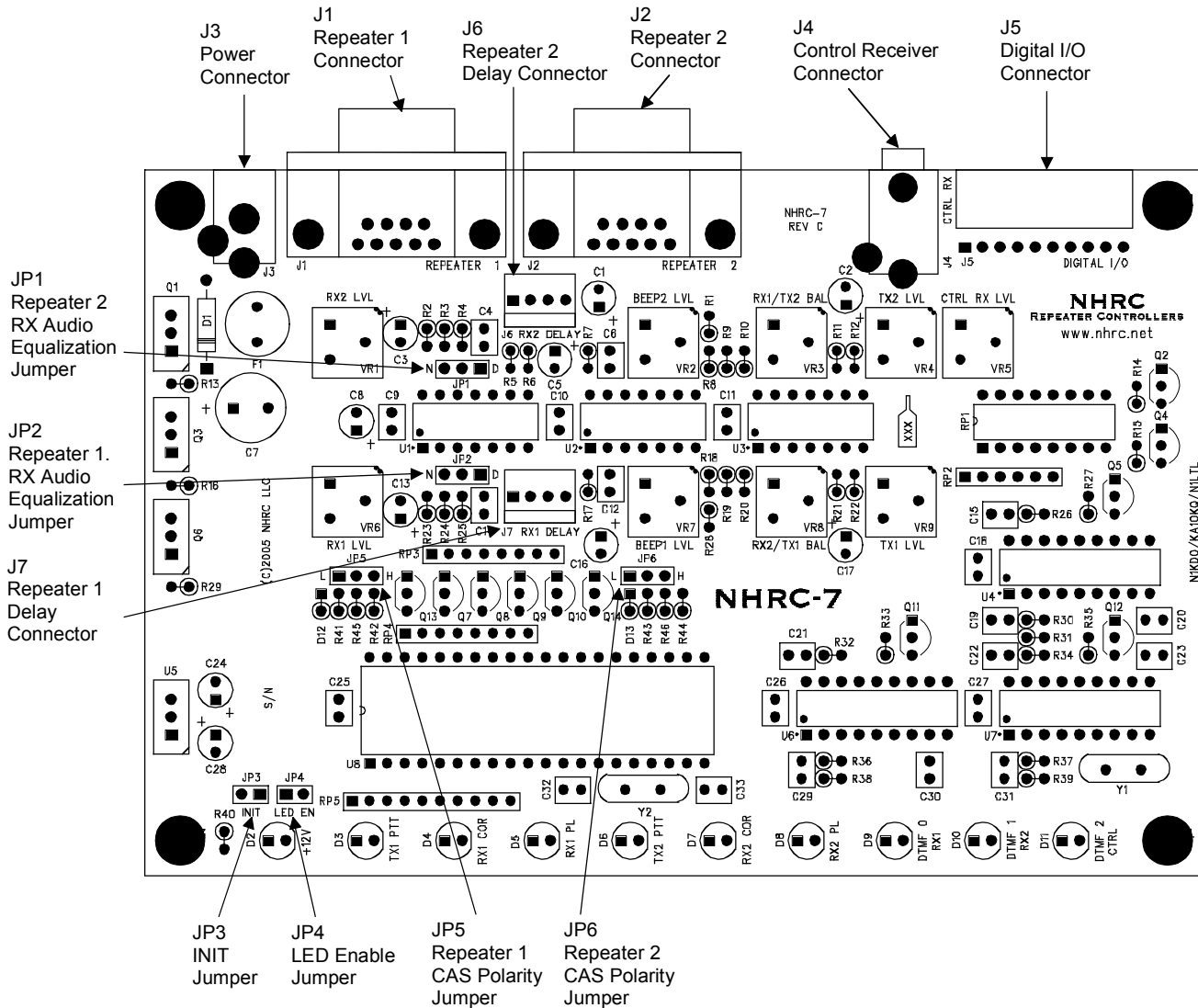
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## 7.2 Jumpers

Connector	Name	Purpose
<b>JP1</b>	“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.
<b>JP2</b>	“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.
<b>JP3</b>	“INIT”	Initialize the controller to factory defaults if power is applied while jumper is installed. Also used to program unlock prefix.
<b>JP4</b>	“LED EN”	This jumper enables the LED status indicators. It can be removed to reduce the current demand of the controller for special applications.
<b>JP5</b>	“L H” (receiver 1 CAS polarity)	Set jumper between L and center pin for active low CAS polarity. Set jumper between H and center pin for active high CAS polarity.
<b>JP6</b>	“L H” (receiver 2 CAS polarity)	Set jumper between L and center pin for active low CAS polarity. Set jumper between H and center pin for active high CAS polarity..

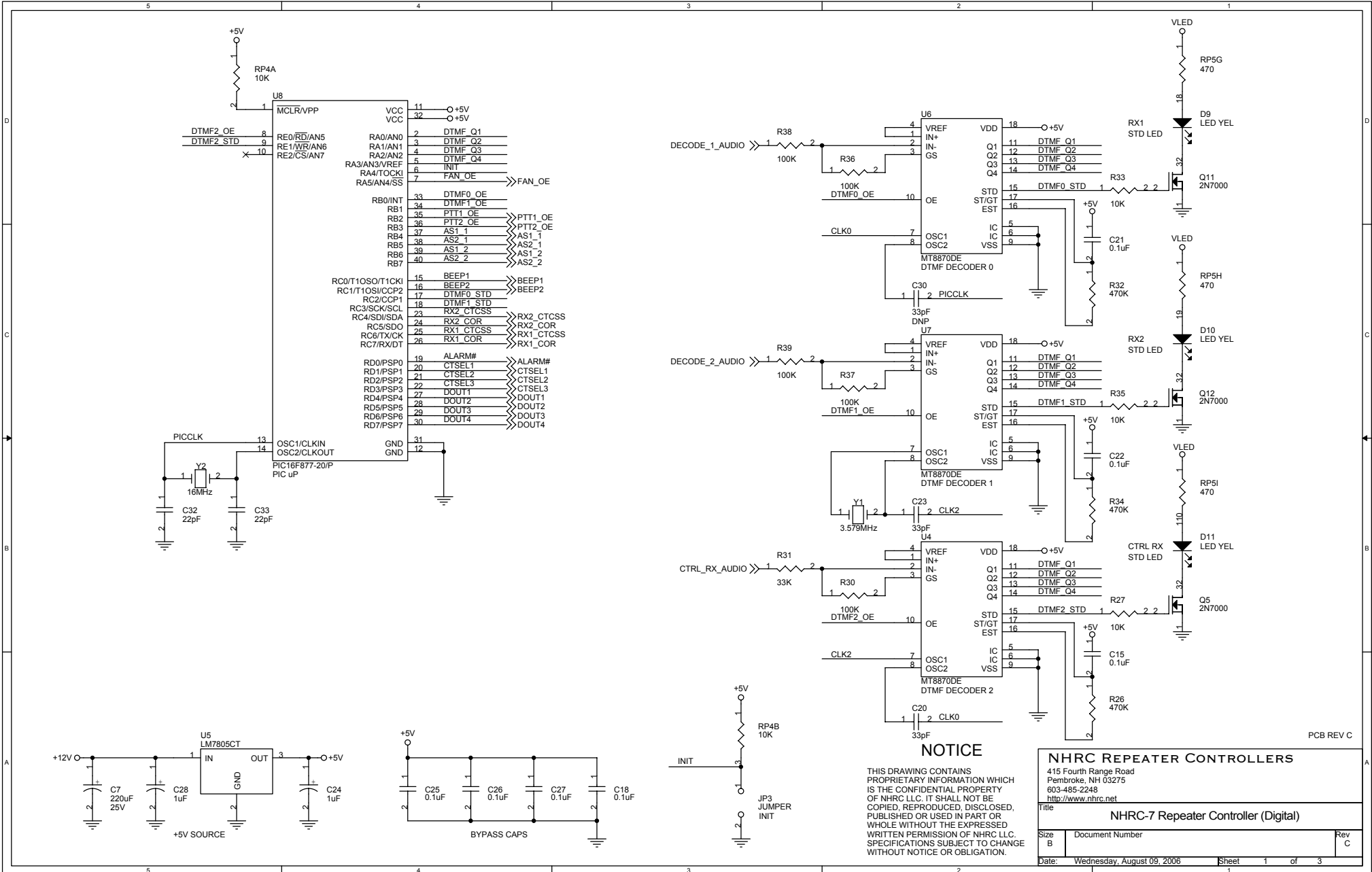
The following pages contain detailed views of the NHRC-7 connectors and controls.

# NHRC-7 User Guide



## **8. Schematics**

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



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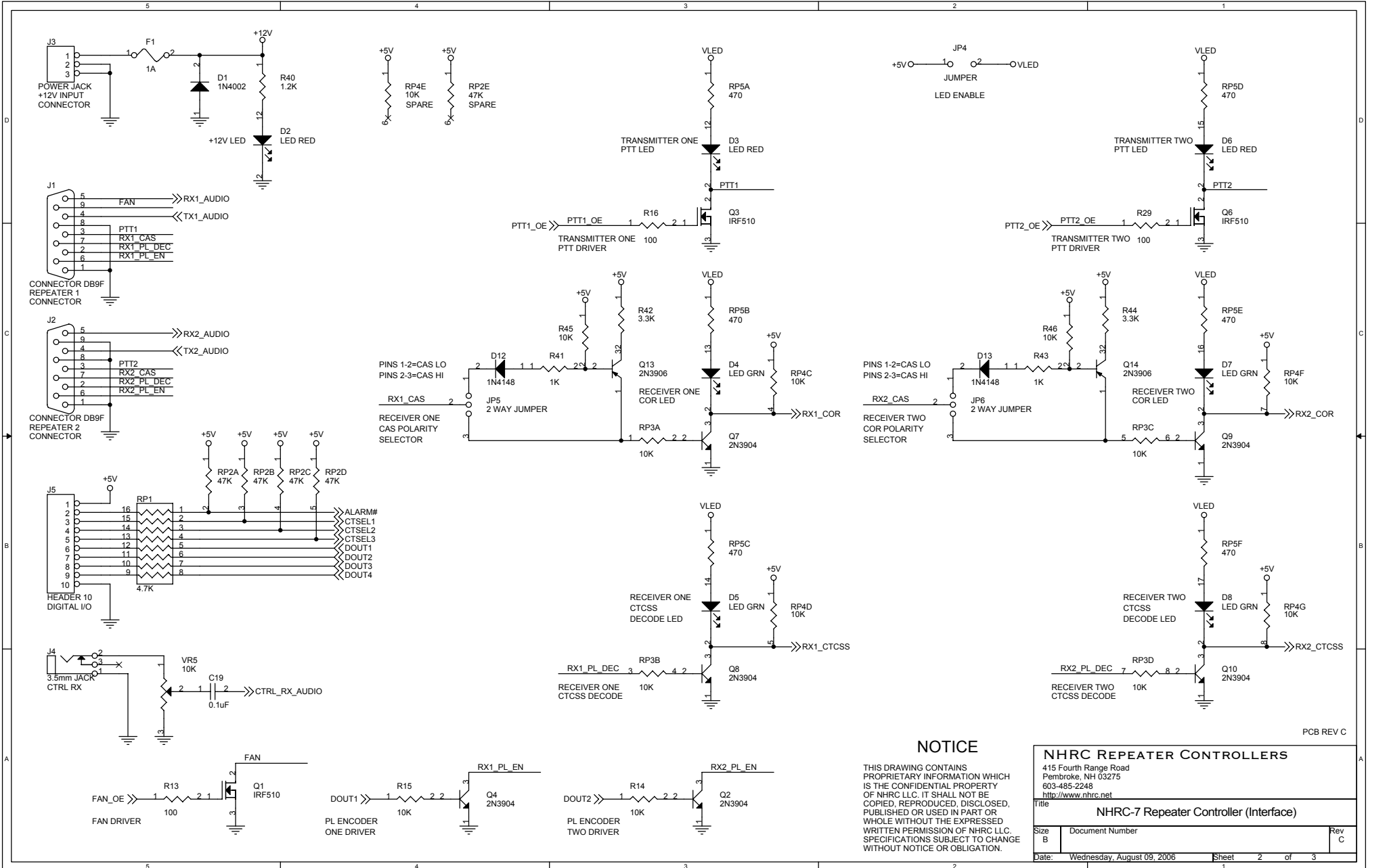
**NHRC REPEATER CONTROLLERS**  
 415 Fourth Range Road  
 Pembroke, NH 03275  
 603-485-2248  
<http://www.nhrc.net>

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

Size B	Document Number	Rev C
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PCB REV C



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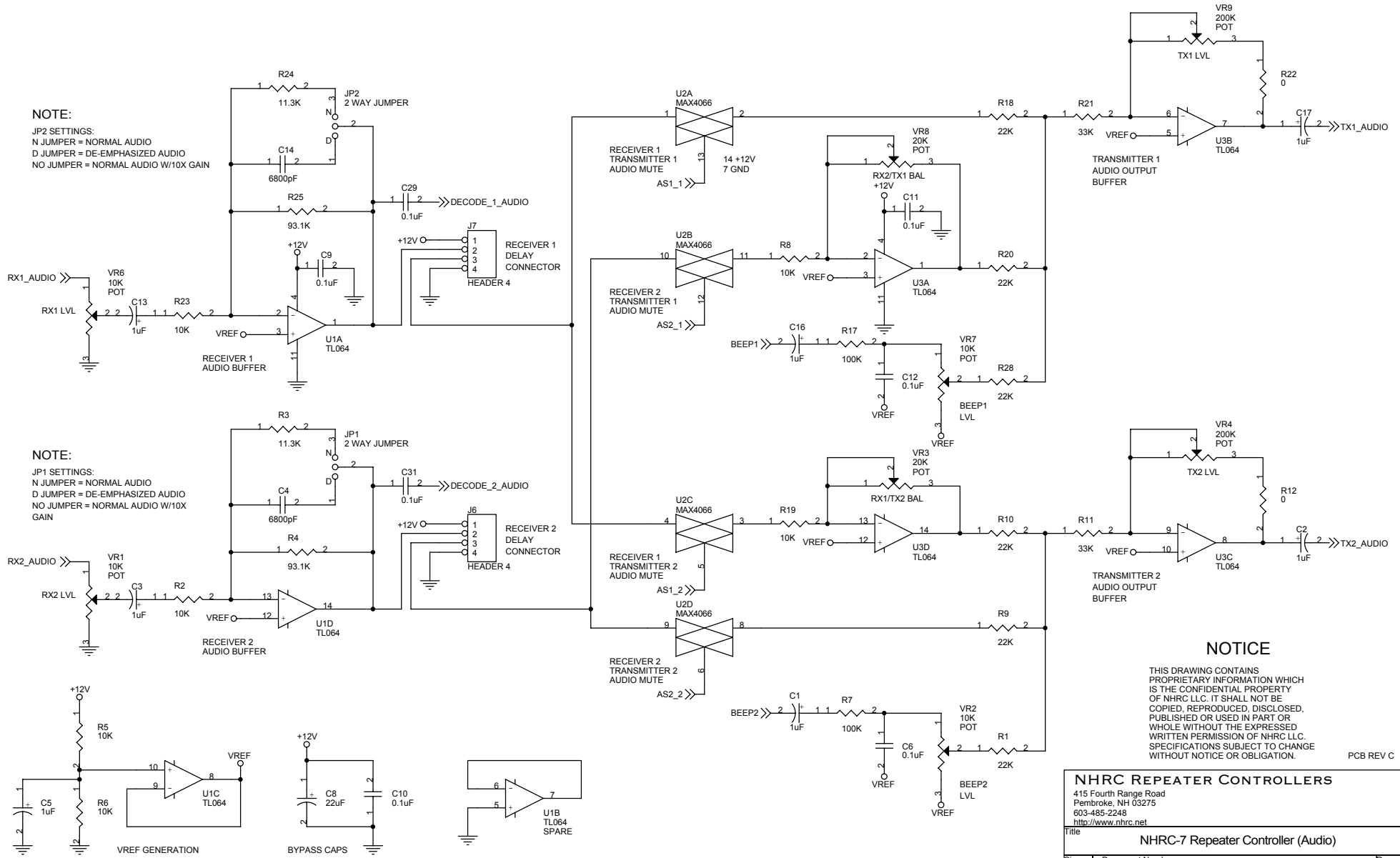
Title: **NHRC-7 Repeater Controller (Interface)**

Size B	Document Number	Rev C
Date: Wednesday, August 09, 2006	Sheet 2 of 3	

PCB REV C

**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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## 9. Parts List

The following is the bill of materials for revision “C” of the NHRC-7 Repeater Controller.

Item	Qty	Reference	Part	Description	Populate	Manufacturer	Manufacturer P/N	Digi-Key P/N
1	9	C1,C2,C3,C5,C13,C16,C17, C24,C28	1uF	1uF 50V Aluminum Electrolytic Capacitor	YES	Panasonic	ECE-A1HKG010	P931-ND
2	2	C14,C4	6800pF	6800pF 100V X7R Ceramic Radial Cap	YES	Kemet	C320C682K1R5CA	399-2041-ND
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	YES	Kemet	C320C104M5U5CA	399-2155-ND
4	1	C7	220uF	220uF 25V Aluminum Electrolytic Capacitor	YES	Panasonic	ECA-1EM221	P5153-ND
5	1	C8	22uF	22uF 25V Aluminum Electrolytic Capacitor	YES	Panasonic	ECA-1EM220	P5149-ND
6	3	C20,C23,C30	33pF	33pF 200V C0G Ceramic Radial Capacitor	YES	Kemet	C315C330J2G5CA	399-1892-ND
7	2	C32,C33	22pF	22pF 200V C0G Ceramic Radial Capacitor	YES	Kemet	C315C220J2G5CA	399-1890-ND
8	1	D1	1N4002	100V 1A GP Diode	YES	Diodes Inc.	1N4002	1N4002DICT-ND
9	3	D2,D3,D6	LED RED	Red T1¼ LED	YES	Lite-On	LTL-4223	160-1127-ND
10	4	D4,D5,D7,D8	LED GRN	Green T1¼ LED	YES	Lite-On	LTL-4233	160-1130-ND
11	3	D9,D10,D11	LED YEL	Yellow T1¼ LED	YES	Lite-On	LTL-4253	160-1133-ND
12	2	D12,D13	1N4148	75V 150mA Switching Diode	YES	Diodes Inc.	1N4148	1N4148DICT-ND
13	1	F1	1A	0.90A PolySwitch	YES	Raychem	RUE090	RUE090-ND
14	4	JP1,JP2,JP5,JP6	2 WAY JUMPER	0.1" 3 Position Vertical Pin Header	YES	Molex	22-28-4030	WM6403-ND
15	2	JP4,JP3	JUMPER	0.1" 2 Position Vertical Pin Header	YES	Molex	22-28-4020	WM6402-ND
16	2	J2,J1	CONNECTOR DB9F	DB9 Female Right Angle PCB Mount Connector	YES	NorComp	182-009-212-531	182-09F-ND
17	1	J3	POWER JACK	2.5mm ID Coaxial Power Jack	YES	CUI	PJ-002B	CP-002B-ND
18	1	J4	3.5mm JACK	3.5mm Mono Audio Jack	YES	CUI	MJ-3536	CP-3536-ND
19	1	J5	HEADER 10	0.1" 10 Position Right Angle Header	YES	Molex	22-05-3101	WM4308-ND
20	2	J6,J7	HEADER 4	0.1" 4 Position Vertical Header	YES	Molex	22-23-2041	WM4202-ND
21	3	Q1,Q3,Q6	IRF510	100V 5.6A N-channel MOSFET	YES	International Rectifier	IRF510	IRF510-ND
22	6	Q2,Q4,Q7,Q8,Q9,Q10	2N3904	60V 200mA GP NPN Transistor	YES	Fairchild Semiconductor	2N3904BU	2N3904FS-ND
23	3	Q5,Q11,Q12	2N7000	60V 200mA N-Channel MOSFET	YES	Fairchild Semiconductor	2N7000	2N7000FS-ND
24	2	Q13,Q14	2N3906	-40V -200mA GP PNP Transistor	YES	Fairchild Semiconductor	2N3906BU	2N3906FS-ND
25	1	RP1	4.7K	4.7K ohm X 8 Isolated DIP Resistor Pack	YES	Bourns	4116R-1-472	4116R-1-472-ND
26	1	RP2	47K	47K ohm X 5 Bussed SIP Resistor Pack	YES	Bourns	4606X-101-473	4606X-1-473-ND

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27	1	RP3	10K	10K ohm X 4 Isolated SIP Resistor Pack	YES	Bourns	4608X-102-103	4608X-2-103-ND
28	1	RP4	10K	10K ohm X 7 Bussed SIP Resistor Pack	YES	Bourns	4608X-101-103	4608X-1-103-ND
29	1	RP5	470	470 ohm X 9 Bussed SIP Resistor Pack	YES	Bourns	4610X-101-471	4610X-1-471-ND
30	6	R1,R9,R10,R18,R20,R28	22K	22K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-22K	22KQBK-ND
31	13	R2,R5,R6,R8,R14,R15,R19, R23,R27,R33,R35,R45,R46	10K	10K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-10K	10KQBK-ND
32	2	R3,R24	11.3K	11.3K ohm 1/4W 1% Metal Film Resistor	YES	Yageo	MFR-25FBF-11K3	11.3KXBK-ND
33	2	R4,R25	93.1K	93.1K ohm 1/4W 1% Metal Film Resistor	YES	Yageo	MFR-25FBF-93K1	93.1KXBK-ND
34	7	R7,R17,R30,R36,R37,R38, R39	100K	100K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-100K	100KQBK-ND
35	3	R11,R21,R31	33K	33K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-33K	33KQBK-ND
36	2	R12,R22	0	Zero ohm 1/4W Jumper	YES	Yageo	ZOR-25-B-52	0.0QBK-ND
37	3	R13,R16,R29	100	100 ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-100R	100QBK-ND
38	3	R26,R32,R34	470K	470K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-470K	470KQBK-ND
39	1	R40	1.2K	1.2K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-1K2	1.2KQBK-ND
40	2	R41,R43	1K	1K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-1K0	1.0KQBK-ND
41	2	R42,R44	3.3K	3.3K ohm 1/4W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-3K3	3.3KQBK-ND
42	2	U1,U3	TL064	Quad JFET Op-Amp	YES	Texas Instruments	TL064CN	296-1773-5-ND
43	1	U2	MAX4066	Quad SPST CMOS Analog Switch	YES	Maxim	MAX4066CPD	MAX4066CPD-ND
44	3	U4,U6,U7	MT8870DE	DTMF Decoder	YES	Zarlink	MT8870DE	
45	1	U5	LM7805CT	5V 1A Linear Voltage Regulator	YES	Fairchild Semiconductor	LM7805CT	LM7805CT-ND
46	1	U8	PIC16F877-20/P	8K X 14 FLASH Microcontroller	YES	Microchip Technology	PIC16F877-20/P	PIC16F877-20/P-ND
47	5	VR1,VR2,VR5,VR6,VR7	10K	10K 6mm Carbon Trimmer Potentiometer	YES	Panasonic	EVN-D8AA03B14	D4AA14-ND
48	2	VR8,VR3	20K	20K 6mm Carbon Trimmer Potentiometer	YES	Panasonic	EVN-D8AA03B24	D4AA24-ND
49	2	VR9,VR4	200K	200K 6mm Carbon Trimmer Potentiometer	YES	Panasonic	EVN-D8AA03B25	D4AA25-ND
50	1	Y1	3.579MHz	3.579545MHz 17pF HC49/U Crystal	YES	ECS	ECS-35-17-4	X079-ND
51	1	Y2	16MHz	16.000MHz 20pF HC-49/U Crystal	YES	ECS	ECS-160-20-4	X176-ND

### **10. NHRC LLC Limited Warranty**

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

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

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

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

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

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

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

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