NHRC
Repeater Controllers

NHRC-10
User Guide

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Printed in the U.S.A.

Thank You!

Thank you for purchasing the NHRC-10 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@nhrc.net***.

Support for the controller is available by email or telephone. Please direct software-related questions via email to ***software@nhrc.net***. Please direct hardware-related questions via email to ***hardware@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-10 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-10 are:

- Recording of four real speech ID messages and three real speech tail messages yourself.
- Local language support using a custom recording capability.
- Six voice mailboxes, five saved operational setup memories, ten timers, and more than 70 control operator functions.
- An audio test mode that records and plays back user's audio.
- A full-duplex autopatch with a database of 250 autodial numbers plus ten emergency autodial slots.
- Support for up to 16 area codes with grant/deny access control to each exchange.
- Land line telephone access for "Reverse Patch" & controller administration.
- DTMF (“Touch Tone®”) pad test.
- Dedicated DTMF receiver for telephone control and optional control receiver. (A separate control receiver audio input with dedicated DTMF receiver is available.)
- Separate control receiver jack and DTMF receiver. DTMF receiver reverts to link port when control receiver is not present.
- Connections for remote base, link radio, or slave repeater.
- Unique courtesy tones to indicate link/remote base status.
- Frequency-agile remote base supports remote control of ICOM IC-706MkIIG®.
- LiTZ (Long Tone Zero)/911 message support; will play dedicated voice message in response to LiTZ or 911 tones to tell user how to use emergency autodials, what other repeater to use, etc.
- Transmitter fan control output automatically runs fan while transmitting and for a programmable delay after.
- Real sine wave audio tones.
- DTMF "Carrier,” “Carrier and CTCSS,” and “Carrier or CTCSS" access modes.
- Granular security features that allow tailored control operator access.

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1.1 Sending commands

All of the controller's commands are sent by DTMF (Touch-Tone®) sequences that can be received on the main repeater, over the telephone, the control receiver (if connected), or the link radio (if the control receiver is not connected).

Commands received over the main repeater or link radio 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.

The telephone and control receiver do not have a CAS signal available. Commands received from these sources will be evaluated when the DTMF inter-digit timer expires.

To send a command over the main repeater,

1. key your transmitter.
2. enter the DTMF command digits.
3. unkey the transmitter.

This will cause the command to be evaluated immediately.

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

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

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

1.2 ID Messages

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

The voice messages are comprised of:

- an "initial" ID message, that plays when the controller has been idle for a period longer than the ID timer, and
- three "normal" ID messages.

Each of the normal ID messages can be individually enabled or disabled.

When more than one normal ID message is enabled, the enabled messages are played in sequence; one each time the ID timer expires.

The CW ID will play when all the voice IDs are disabled, or when the repeater is keyed during a voice ID message.

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1.3 "Unlocked Mode"

All of the controller's important programming information is protected by a special password, the "unlock code."

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

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

When the unlock code is successfully entered into the controller, the controller will say "control access enabled," and a special courtesy tone will be used to indicate the controller is unlocked.

The controller can be locked by:

- sending the "#" command, or
- it will lock itself after two minutes of inactivity.

When the controller leaves the unlocked mode:

- it will say "control access disabled," and
- the courtesy tone will revert to the normal tone for the controller's current state.

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2. Electrical Connections

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

- power,
- repeater and link radios,
- the control receiver, and
- NHRC-DAD digital audio delay boards.

It is intended for the repeater operator to use in the planning and installation of the NHRC-10 Repeater Controller into a repeater system.

2.1 Input and Output Signal Levels

Control signals into the NHRC-10 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.

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.

The optional NHRC-10_DOUT digital output board provides eight additional digital outputs. These 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.

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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 "J7 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.

J7 12V Connector Pin-out

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

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2.3 Repeater Connector

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

J1 is a Female DB9 Connector.

A Male DB9 Connector is included with the controller.

Male DB-9 Connector

J1 REPEATER Connector Pin-out

Pin #	Use	Comments
1	Ground	
2	CTCSS Decode	Active High
3	PTT	Active Low
4	Transmit Audio	From Controller
5	Receiver Audio	To Controller
6	CTCSS Encode	Future Option
7	CAS	Active High
8	Ground	
9	Fan Control	Active Low

⇒ ***Note:*** The Fan Control output can be configured to either serve as a timed fan control switch or as a digital output for other control applications. See Section 4.4 for information on the operation of the fan control output.

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2.4 Link/Remote Base Connector

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

J2 is a Female DB9 Connector.

A Male DB9 Connector is included with the controller.

Male DB-9 Connector

J2 REMOTE BASE Connector Pin-out

Pin #	Use	Comments
1	Ground	
2	CTCSS Decode	Active High
3	PTT	Active Low
4	Transmit Audio	From Controller
5	Receiver Audio	To Controller
6	CTCSS Encode	Future Option
7	CAS	Active High
8	Ground	
9	Ground	

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2.5 Control Receiver Connector

The control receiver, if present, is connected to the "J6 CTRL RX" jack. J6 is a 3.5 mm monophonic mini-phone jack.

3.5 mm mini-phone plug

If the control receiver is connected, then the control DTMF decoder will get the control receiver audio.

If the control receiver is not connected, then the control DTMF decoder will get the link/remote base audio.

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

J6 CTRL RX Connector Pin-out

Pin #	Use
Sleeve	Ground
Tip	Control Receiver Audio

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2.6 Delay Connectors

The NHRC-10 supports the NHRC-DAD, a CODEC digital audio delay, to reduce squelch crashes and fully mute DTMF tones.

Jacks “J3 MAIN DELAY” and “J4 RB DELAY” are provided on the controller to interface NHRC-DADs.

Jacks J3 and J4 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.

J3 MAIN DELAY and J4 RB DELAY Connector Pin-out

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

See Section 4.4 for information about enabling a connected DAD.

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2.7 CI-V Connector

The NHRC-10 has an integrated CI-V interface which can be used to control Icom® CI-V compatible radios. The controller is intended to be mated to a IC-706 Mk II G®.

The “J5 CI-V” connector allows the controller and radio to communicate. This allows repeater users to operate the IC-706 Mk II G® as a frequency-agile remote base from 160 meters through 70 centimeters, with the exception of the 222 MHz band.

The CI-V control on the NHRC-10 should work with any modern Icom® radio that supports CI-V, with the exception of the IC-731® and IC-735®, which use an incompatible frequency control format. The radio's CI-V configuration should be set up as follows:

- "CI-V Address" 48H.
- "CI-V Baud" 9600.
- "CI-V Transceive" off.
- "CI-V 731" off.

CI-V interconnection requires a shielded patch cord with 3.5 mm mini-phone plugs on each end. One end connects to the "J5 CI-V" jack on the NHRC-10, the other end connects to the CI-V jack on the Icom® transceiver.

3.5 mm mini-phone plug

J5 CI-V Connector Pin-out

Pin #	Use
Sleeve	Ground
Tip	CI-V Data

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2.8 Main Repeater/Remote Base Accessory Connectors

The NHRC-10 provides connectors J12 and J13 to support optional NHRC-Squelch boards or CTCSS decoders inside the repeater controller cabinet. These jacks provide the receiver audio, COR, and CTCSS signals to allow easy connection of these optional devices.

J12 MAIN ACCY and J13 RB ACCY Connector Pin-out

Pin #	Use	
1	+12	100 mA max.
2	Receiver Audio	
3	CTCSS Decode	Active high
4	CAS	Active high
5	Ground	

The Receiver Audio, CTCSS Decode, and CAS connections on the accessory jack are in parallel with the connections on the DB9 Repeater and Remote Base connectors.

2.9 Optional NHRC-10-DOUT Eight-Port Digital Control Output Board

The NHRC-10 can be equipped with the optional NHRC-10-DOUT eight-port digital control output board. The NHRC-10-DOUT allows the NHRC-10 repeater controller to control up to eight external loads. These outputs can be used to select power amplifiers, disable voter channels, etc.

The NHRC-10-DOUT 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.

⇒ ***Note:*** See Sections 4.7, 4.8, and 5.10 for information on the configuration and operation of the NHRC-10-DOUT.

⇒ ***Note:*** See Section 2.3 for information about the NHRC-10s built-in digital output/fan control output.

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2.10 Audio Level Adjustment

Description of Audio Processing:

The NHRC-10 uses analog switching and audio mixing to route audio from audio sources to the transmitter ports, voice recorder and phone patch.

The controller has two internal mix busses that supply audio to the various outputs. The transmitter mix bus supplies audio to the main and remote base transmitters. The phone mix bus supplies audio to the telephone line. Each mix bus has a variety of audio sources.

Each audio path through the controller is described in detail below.

The main receiver's audio is passed into the controller through potentiometer VR5, and then buffered through audio amplifier U1A for impedance isolation and equalization. This amplifier can be set up to provide flat audio response or 6 dB/octave de-emphasis with a roll-off of approximately 250 Hz, allowing the use of discriminator audio. The buffered audio is then passed to touch-tone decoder U12, and through connector J3 to the *optional* digital audio delay board for squelch tail elimination. If the digital audio delay is not present, J3 pins 2 and 3 must be jumpered to allow audio to continue to pass through the controller. After the digital audio delay connector, the main receiver audio is gated through analog switch U3A. The gated audio is supplied to the transmitter mix bus via , potentiometer VR7, the phone mix bus via potentiometer VR9, and into the digital voice recorder (DVR) chip via potentiometer VR11.

The remote base receiver's audio is passed into the controller through potentiometerVR1, and then buffered and equalized through audio amplifier U1D, identically to the main receiver audio. The buffered audio is presented to J4 for the remote base receiver's *optional* digital audio delay board. If the digital audio delay is not present, J4 pins 2 and 3 must be jumpered to allow audio to continue to pass through the controller. Remote base audio is gated through analog switch U3B, directly onto the transmitter mix bus.

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

DTMF and courtesy tones are generated by tone generator U14, buffered by amplifier U2A, and provided to the phone mix bus at a fixed level. The buffered tones are also provided to the transmitter mix bus through potentiometer VR6, buffer amplifier U1B, and analog switch U3C.

DVR output is buffered by amplifier U2B and provided to the phone mix bus. The buffered DVR output is also provided to the transmitter mix bus via potentiometer VR10, and through amplifier U1B and analog switch U3C, which are shared with the DTMF and courtesy tone generator.

Phone audio is provided to the transmitter audio mix bus through potentiometer VR2, buffer amplifier U1C, and analog switch U3D.

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The transmitter mix bus is provided to the main transmitter through buffer amplifier U4A, with it's level adjusted with potentiometer VR8. The transmitter mix bus is also provided to the remote base transmitter through buffer amplifier U4D, with it's level adjusted with potentiometer VR3.

The phone mix bus is sent to the phone line through buffer amplifier U4B.

Control receiver audio enters the controller through jack J8. If nothing is connected to J8, then the remote base receiver audio is used for control receiver audio. Potentiometer VR4 sets the control receiver audio level into DTMF decoder U7.

Note: the DTMF, courtesy tone and speech levels into the phone line are fixed levels and are not adjustable.

The J10 header is a test point for monitoring the audio levels on the transmitter mix bus. The audio at this point is biased at approximately 6 VDC and should be AC-coupled through a capacitor if it is to be used with an amplified speaker for monitoring levels. Care should be taken not to load the transmitter mix bus with a low-impedance load on J10.

Description of Controls:

VR1 sets the remote base receiver audio input level to the remote base receiver audio processing circuit.

VR2 sets the incoming telephone level to the transmitter audio mix bus. Use this control to increase or decrease the audio level coming in from the phone line.

VR3 is the remote base transmitter master audio level adjustment Use this to adjust the remote base transmitter deviation.

VR4 sets the control receiver DTMF decoder input level. This control sets the audio level into the Control receiver DTMF decoder U7. Set this potentiometer for reliable DTMF decode as indicated by LED D12 lighting each time a DTMF signal is received on the control channel.

VR5 sets the main receiver's input level into the audio processing stage of the controller. This pot is used as an attenuator to reduce (if necessary) the amplitude of the incoming audio signal from your repeater receiver. This control will affect the main DTMF decoder (U12) and will also affect the level of the receiver into the phone line. Adjust this pot for good receiver drive down the phone line. Use VR7 to reduce receiver level into the transmitter mix bus if necessary. (Note: see VR9 for more phone line drive information.)

VR6 is used to adjust the level of the courtesy tone and DTMF tones into the transmitter audio mix bus. Use this control to increase or decrease the level of the courtesy tone and DTMF tones into the transmitter audio mix bus. This adjustment has no effect on the levels of the courtesy tone or DTMF tones into the phone line.

VR7 is the processed audio output adjustment. This adjustment sets the main receiver level into the transmitter mix bus.

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VR8 is the main transmitter's master audio adjustment. Use this to make adjustments to the overall main transmitter deviation.

VR9 is the phone drive level. Use this adjustment to increase or decrease the incoming receiver audio level into the phone line. This adjustment is affected by the setting of VR5, the main RX level adjustment. If sufficient audio into the phone line is not attainable, then it is likely that VR5 is set to low. Readjust VR5 for more input level.

VR10 is used to set the output of the DVR into the transmitter audio mix bus. Use this control to increase or decrease the audio level coming out of the DVR into the transmitter audio mix bus. This control has no effect on the speech level from the DVR into the phone line.

VR11 is used to set the DVR input level for recording. Use this adjustment to increase or decrease the record level into the DVR chip.

Audio Level Setup:

Recommended equipment:

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

Procedure:

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

1. Prepare the controller for audio alignment by setting all potentiometers to the midrange position, and properly configuring the input equalization (normal or de-emphasized) by setting jumpers JP3 and JP1.
2. Transmit the reference tone through the repeater, and adjust VR5 for reasonable transmitted deviation, about 3 KHz. The final adjustment of VR5 will occur later. Turn off the reference signal.
3. Transmit some DTMF tones into the repeater, and adjust VR5 for reliable DTMF decoding, as indicated by LED D10. (note VR-5 affects the rx audio into the phone line and will be covered later in this section)
4. Initiate a phone patch. Adjust VR9 for solid receiver audio into the phone line. If sufficient audio drive cannot be obtained at the maximum setting of VR9, then adjust VR5 until sufficient drive is obtained. Don't worry about phone audio into the transmitter at this time, it will be set later. Hang up patch when you are satisfied with this adjustment.

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5. This completes the initial receiver input adjustments. The next steps will adjust all audio levels into the transmitter mix bus. The goal is to get the main receiver, remote base receiver, and DVR output levels on the mix bus equal, and the courtesy tone/DTMF generator set to a reasonable level. An oscilloscope connected to the monitor connector (J10) is a useful aid in this step.

6. Use VR7 to set the received audio repeat level.

7. Use VR6 to set the courtesy tone to a reasonable level.

8. Unlock the controller and force it to speak with the *800 command. Set the DVR playback level with VR10. Lock the controller.

9. Initiate a patch and set the incoming phone audio to a reasonable level with VR2. Send some DTMF tones though the phone from the remote end and verify that LED D11 indicates reliable DTMF decoding from the phone line. The controller will now respond to commands from the phone line.

10. Set the DVR input level. This is best set by recording a test message and allowing it to play back. Adjust the input level so that the test message is played back at the same level as it originally passed thorough the repeater. It also should be the same level as the factory default words recorded into the DVR. Overdriving the DVR will result in compression of recorded audio, complete with "noise pumping" effects, so it is important that the level is not set too high.

11. *Hint:* Set up your signal generator with the test tone. Turn generator output off. Use a handheld radio to send the test message command (default 11) and then un-key. Turn on the generator. Note the deviation of the *repeater's* transmitted signal. Shut off the generator. The DVR will now play back the recorded test tone. Note the deviation. Repeat this test and adjust the DVR input until the record and playback deviation is the same. ***Be careful*** to remember to subtract out your CTCSS deviation to get a true DVR deviation measurement.

12. Turn on the remote base. Send the test tone on the remote base Rx freq. Set the incoming level to be similar to other levels on the audio bus by adjusting potentiometer VR1.

13. Transmit a test tone into the repeater and set the remote base transmit deviation with potentiometer VR3.

14. Adjust the main transmitter deviation with VR8.

15. The control receiver audio enters the controller at jack J8, unless nothing is plugged into J8, in which case, the controller will use the remote base receiver audio as the control receiver. In either case, potentiometer VR4 adjusts the control receiver audio level into DTMF decoder U7. VR4 should be adjusted so that received DTMF tones are reliably detected as indicated by LED D12.

Note: DVR and DTMF levels into the phone line are fixed and cannot be adjusted.

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2.11 The LED Indicators

The NHRC-10 has ten 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-10 LED Indicator Functions

LABEL	COLOR	USE
+12V	Red	Power Indicator
MAIN PTT	Red	Main Repeater Transmit
MAIN COR	Green	Main Repeater Unsquelched
MAIN PL	Green	Main Repeater CTCSS Detect
RB PTT	Red	Link/Remote Base Transmit
RB COR	Green	Link/Remote Base Unsquelched
RB PL	Green	Link/Remote Base CTCSS Detect
DTMF1	Yellow	Main Repeater DTMF Detect
DTMF2	Yellow	Phone Line DTMF Detect
DTMF3	Yellow	Link/Remote Base or Control Receiver DTMF Detect

Jumper JP4 enables all the LEDs with the exception of the power LED. JP4 can be removed to reduce the current consumption of the NHRC-10 for low-power applications, such as solar or wind powered repeaters.

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3. Programming the Controller

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

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

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

3.1 Quick Start

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

Procedure:

- **Make all the necessary electrical connections**. See Section 2.
- **Install the initialize jumper** (SW1, located in the lower left-hand corner of the board.)
- **Apply power to the NHRC-10**. After a short pause, the controller will announce the software version and the initial ID. 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 (15) to the controller**. The controller should respond "control access enabled."
- **Use the *2 command to program command prefix 15: the unlock prefix**. To program the unlock code to 314159, send the following command: *2 15 314159.
- **Send the "#" command to lock the controller**. The controller should respond "control access disabled."
- **Remove the initialize jumper** (SW1, located in the lower left-hand corner of the board.)

You should record the voice ID messages (#96, 97, 98, and 111) and program the CW ID at this time. See Sections 3.10 and 3.11 for information on programming the CW ID and recording voice messages.

Important Voice Tracks

Message Number	Message Contents	Message Length (Seconds)
96	Normal ID 1	8.0
97	Normal ID 2	8.0
98	Normal ID 3	8.0
111	Initial ID	32.0

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This is a good time to program all the command prefixes. See Section 3.5.1 for information on programming command prefixes.

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

3.2 Initializing the Controller

Initializing the controller will re-program the controller's non-volatile EEPROM memory with the factory defaults. All customized settings are lost, including command prefixes, timer presets, CW ID, autodial slots, autopatch setup, etc.

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

Procedure:

- **Install the initialize jumper** (SW1, located in the lower left-hand corner of the board.)
- **Apply power to the controller.** After a short delay of about 10 seconds, the controller will announce the version of software and play the initial ID message.
- **Remove the initialize jumper** (otherwise the controller will initialize again the next time it is powered up).

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

See the Appendix of factory defaults for the controller.

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*3.3 *0: Unlocked Mode Control Operator Access*

3.3.1 Set control operator switches

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

The format of this command is

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

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

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

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

Upon receipt of a valid *0 command without the state, the controller will say 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: “control zero point zero is enabled.”

See Section 4 for more information about control operator switches.

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*3.4 *1: Save Setup*

The NHRC-10 Repeater Controller has 5 “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.

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 “OK.”

The other setups can be loaded by using the load saved setup command:

See Section 5.13 for information about the Load Saved Setup command.

Example: To save the current controller state (all 10 control operator switch groups) as state #1, send the following command with the controller unlocked: "*11". The controller will say "OK" if the command is accepted.

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*3.5 *2: Program Command Prefixes*

Every command accepted by the NHRC-10 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 emergency autodial prefix to 1234 and the autodial prefix to 12345, because the controller would not understand whether 123456 meant to emergency autodial slot #56 or to autodial slot #6.

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. 0-9, A-D, * and # are valid.

After a valid command is received, the controller will respond "OK."

Command Prefixes by Number

Prefix Number	Description	Prefix Number	Description
00	Control Operator	**08**	DTMF test
01	Autopatch	**09**	Reverse Patch
02	Unrestricted Autopatch	**10**	Digital Output Control
03	Autodial	**11**	Voice Mailboxes
04	Emergency Autodial	**12**	Remote Base
05	Patch Hang Up	**13**	LiTZ Message
06	DTMF Access	**14**	Load Saved Setup
07	Retransmit DTMF	**15**	Unlock Controller

⇒ **Note:** For security reasons, command prefixes will never be sent over the air by the controller.

Example: To set the DTMF access prefix to 4321, send the following command with the controller unlocked: "*2 06 4321 The controller will say "OK" if the command is accepted. Note that the spaces in the sample command string are for illustration purposes only. In actuality, there are no spaces.

⇒ **Note:** For security reasons, *command prefix 15 (the unlock code) cannot be changed unless the initialize jumper (SW1) 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 autopatch code is set to "123", and the DTMF test code is set to "1234", then when a user sends "1234123456" the controller will try to autopatch 4123456, rather than correctly reading back the first six DTMF digits.

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*3.6 *3: Set timers*

The NHRC-10 has 13 “timers,” two of which are not really timers, but are event counters.

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

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

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

The phone ring counter is used to cause the controller to answer the phone after the n^{th} phone ring.

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3.6.1 Program a timer

The NHRC-10 timers are programmed as follows:

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

<nn> specifies the timer to set. Valid range is 00 to 12. Both digits must be present. Consult the NHRC-10 Timers by Number Table for the timer number.

<time> is optional. If present, it is the value to program the timer to. The valid range for <time> is 0 to 255. If time is omitted, the current timer value will be announced.

After a valid set timer command is received, the controller will announce the timer value, i.e., "Timer one is fifty."

NHRC-10 Timers, by Number

Timer No.	Description	Timer Resolution	Timer No.	Description	Timer Resolution
00	Hang timer long	.1 sec	**07**	Time-out timer long	1 sec
01	Hang timer short	.1 sec	**08**	Time-out timer short	1 sec
02	ID timer	10 sec	**09**	DTMF mute timer	.1 sec
03	Patch timer	10 sec	**10**	Fan timer	10 sec
04	Autodial timer	10 sec	**11**	Tail message counter	units
05	Emergency autodial timer	10 sec	**12**	Phone ring counter	units
06	DTMF access timer	10 sec	**13**	Remote Base Idle Shutoff Timer	10 sec

Examples:

To program the patch timer to 3 minutes (180 seconds), send the following command with the controller unlocked: "*3 03 18". If the command is accepted, the controller will respond "timer three is eighteen."

To find out what the fan timer is set to, send the following command with the controller unlocked: "*310". If the fan timer was set for 120 seconds, the controller will respond with "timer ten is twelve."

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 "timer zero is two hundred."

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*3.7 *4: Program Autopatch Restrictions*

The NHRC-10 Repeater Controller has flexible calling restrictions which allow the repeater operator the ability to grant or deny access to any of the 800 telephone exchanges in up to 16 different area codes.

This flexibility comes at the price of increased setup complexity. Some repeater operators may not even want to use the restrictions.

Those who have a telephone line secured from long distance by calling restrictions placed on the line by the telephone company may simply not use the calling restrictions, and give the users the Unrestricted Autopatch code.

Autopatch Restriction Rules:

- The controller supports up to16 area codes.
- One of these (#15) can optionally be used for the "local" area code for locations that still support 7- and 8-digit dialing.
- Each area code has 800 possible exchange codes that can be used.
- Each exchange in each area code can be individually controlled.

⇒ **Caution:** Do not program any of the 16 area codes to any three-digit combination that ends in 11 (111, 211, 311, 411, 511, 611, 711, 811, 911) or enable the 911 exchange in area code #15 if it is configured as the local area code. Doing this would allow autopatch users to place a 911 call which is better supported with the emergency autodials.

3.7.1 Assign an area code number to a bank

To program the area code number into the banks, use the *40 (Program Area Code) command as follows:

***40<bb><code>** where:

<bb> specifies the area code bank. The valid range is 00 to 15. Both digits must be specified.

<code> specifies the 3-digit area code. Valid range is 000-999. If left absent, the controller will say what the area code is for the indicated bank.

After a valid Program Area Code command is received, the controller will say:

- "OK" if the area code was programmed, or
- the area code itself if the area code was not specified in the command (inquiry mode).

Example: To program area code bank 2 to be 603, send the following command with the controller unlocked: "*40 02 603". The controller will say "OK" if the command is accepted. Note that the spaces in the sample command string are for illustration purposes only. In actuality, there are no spaces.

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3.7.2 Set area code bank options

Each area code bank has five options that can be set or reset. Consult the Area Code Bank Options table below for the option numbers.

Area Code Bank Options

Option	Description
0	Bank Enable
1	A leading 1 is allowed.
2	A leading 1 is required.
3	This bank is the local area code (bank 15 only!)
4	Use dialing prefix

To program area code bank options, use the following command:

***41<bb><o><s>**

<bb> specifies the area code bank. The valid range is 00 to 15. Both digits must be specified.

<o> specifies the option number. The valid range is 0 to 4.

<s> sets the state of the option. 0 for off, 1 for on.

Example: To enable bank 3, send the command *41 03 0 1.

⇒ ***Note:*** Because there are 800 exchanges in every area code (200-999), it could be very time consuming to individually enable or disable every one, so the *42 command (see below) is provided to change the state of all 800 exchanges with a single command.

3.7.3 Enable or disable an entire area code bank

Command *42 can enable or disable an entire area code bank with a single command. Use command *42 as follows:

***42<bb><s>** where:

<bb> specifies the area code bank. The valid range is 00 to 15. Both digits must be specified.

<s> sets the state of all the exchanges. 1 for enabled, 0 for disabled.

Example: To enable all the exchanges in area code bank 3, enter the command *42 03 1.

The *42 command can be used after analyzing the number of exchanges the repeater operator wants to enable or disable in the area code. If most exchanges are to be enabled,

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use state 1 to turn on all the exchanges, then use command *43 to disable individual exchanges. If most exchanges are to be disabled, then use command *42 with state 0 to disable all exchanges, then use command *43 to enable individual area codes as required.

3.7.4 Enable or disable individual exchanges within an area code bank

To enable or disable individual exchanges in the area code bank, use command *43 as follows:

***43<bb><exc><s>** where:

<bb> specifies the area code bank. The valid range is 00 to 15. Both digits must be specified.

<exc> specifies the exchange to enable or disable. The valid range is 200-999.

<s> sets the state of the exchange. 1 for enabled, 0 for disabled.

Example: To enable exchange 485 in area code bank 3, send the command *43 03 485 1.

Example: .To disable all 10- and 11-digit dialing, and enable only 7-digit numbers that start with 555, use the following commands:

*41 00 0 0	(disable bank 0)
*41 01 0 0	(disable bank 1)
	(repeat to disable all banks 01-14)
*41 15 0 1	(enable bank 15 - bank 15 is the local dial bank.)
*41 15 1 0	(no optional leading 1)
*41 15 2 0	(no required leading 1)
*41 15 3 1	(bank 15 is the local (7-digit) area code.)
*42 15 0	(disable every exchange in bank 15)
*43 15 555 1	(enable 555 exchange in bank 15)

If this example is unclear to you, please refer back to the descriptions of the *41 and *42 commands, with particular attention to the <bb>, <exc>, <s>, etc.

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3.7.5 Set Area Code Dialing Prefix

Each area code can have it's own dialing prefix. You may wish to have a long-distance area code dial an access number before dialing the long distance number, or your phone line may be on a PBX, requiring a "9" before dialing. The area code prefix is provided to allow the controller to make these kinds of calls.

To program the dialing prefix, use command *44 as follows:

***44<bb><prefix>** where:

<bb> specifies the area code bank. The valid range is 00 to 15. Both digits must be specified.

<prefix> specifies the numbers to dial before the user's telephone number. Up to 10 DTMF digits can be programmed. The "#" key will insert a 1 second pause in the dialing stream.

Example: To set area code bank 03 to send a "9" and a one-second pause before dialing, send the command *44 03 9#

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*3.8 *5: Program Autodial Slots*

The NHRC-10 Repeater Controller supports 250 autodial slots and 10 emergency autodial slots. Each slot can be programmed, cleared, or the controller will read back the stored phone number.

3.8.1 Program an emergency autodial number

To program or say the phone number in an emergency autodial slot, use the *50 command:

***50<n><number>** where:

<n> is the emergency autodial slot number. Valid range is 0 to 9.

<number> the phone number to program into that slot. 1-15 digits. Leave this blank to inquire.

If a slot is successfully programmed, the controller will say “OK.”

If the number is left blank, then the controller will read back the autodial slot contents.

Example: To program emergency autodial #3 to be 602-473-5111, send the following command with the controller unlocked: "*50 3 6024735111”. The controller will say "OK" if the command is accepted.

To inquire what the number is in emergency autodial #3 is, send the following command with the controller unlocked: "*503”. In the case of the example above, the controller will say "six zero two four seven three five one one one."

3.8.2 Clear an emergency autodial number

To clear (delete) an emergency autodial, use the *51 command:

***51<n>** where:

<n> is the emergency autodial slot number. Valid range is 0 to 9.

If a slot is successfully cleared, the controller will say “OK.”

Example: To clear (erase) emergency autodial slot #2, send the following command with the controller unlocked: "*51 2”. The controller will say "OK" if the command is accepted.

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3.8.3 Program a normal autodial number

To program or say the phone number in a normal autodial slot, use the *52 command:

***52<nnn><number> where:**

<nnn> is the normal autodial slot number. Valid range is 000 to 249. All three digits must be specified.

<number> the phone number to program into that slot. 1-15 digits. Leave this blank to have the controller read back the phone number in the slot..

If a slot is successfully programmed, the controller will say “OK.” If the number is left blank, then the controller will read back the autodial slot contents.

Example: To program autodial slot #63 with 408-555-3311, send the following command with the controller unlocked: "*52 063 4085553311”. The controller will say "OK" if the command is accepted.

To inquire what phone number is stored in autodial slot #63, send the following command with the controller unlocked: "*52 063”. In the case of the example above, the controller will say "four zero eight five five five three three one one."

3.8.4 Clear a normal autodial number

To clear (delete) a normal autodial, use the *53 command:

***53<nnn>** where:

<nnn> is the normal autodial slot number. Valid range is 000 to 249. All three digits must be specified.

If a slot is successfully cleared, the controller will say “OK.”

Example: To clear (erase) autodial slot #063, send the following command with the controller unlocked: "*53 063”. The controller will say "OK" if the command is accepted.

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*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 a CW ID

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

***70<dd…dd…dd…>** where:

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

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

Example: To program "DE N1KDO/R" as the CW ID, the following command would be entered: *70 31 32 11 62 01 52 63 12 72. Note that 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-10 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 01-99. Both digits must be specified. Tone is the number of the tone from Section 6.1.3, the courtesy tone components table.

Example: The default courtesy tone #0,(four 50 mSec bursts of notes E5, G5, B5, D6) would be programmed like: *71 0 0517 0520 0524 0527.

Note: There are 2 "magic" courtesy tone settings. Programming 0000 will play voice track #104, and programming 99nn will play the single CW letter specified by nn. See Section 6.1.4, the CW Character Table, to look up the code for the CW character.

Courtesy Tone Uses

Tone	Use
0	Main receiver courtesy tone.
1	Main receiver courtesy tone, link alert mode, link receiver active
2	Main courtesy tone, link transmit enabled
3	Link receiver courtesy tone, link transmit disabled.
4	Link receiver courtesy tone, link transmit enabled.
5	Reserved
6	Reserved
7	Controller unlocked courtesy tone

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*3.11 *8: Play/Record Voice Tracks*

The *80 command is used to play stored voice messages. The *81 command is used to record voice messages:

3.11.1 Play a message

The controller is capable of storing and playing 123 voice tracks. (See speech vocabulary table, section 6.3.)

Command *80 is used to play messages:

***80<n>** where:

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

Example: To play back the initial ID message (message #111), send the following command with the controller unlocked: "*80 111". The controller will play back the initial ID message.

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3.11.2 Record a message

The repeater operator will want to customize some or all of these messages. The controller's speech IDs, tail messages, and timeout message should all be recorded by the repeater operator. The *81 command allows the repeater operator to record their preferred voice messages.

Tracks 0 through 95 were prerecorded at the factory with a high-performance recording system. The controller uses these messages for its own prompt tracks. The repeater operator may choose to re-record these messages over the air:

- to convert to local language, or,
- just because the operator prefers their own voice.

⇒ **Note:** The fidelity of these messages when recorded over the air is not likely to approach the fidelity of the messages recorded at the factory.

⇒ **Caution:** If you record over the factory voice prompt tracks (0 through 95), there is no way to recover the original recording, short of replacing the ISD4004 part with a freshly recorded part from the factory.

Command *81 is used to record messages.

***81<n>** where:

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

To record a message, enter *81, followed by the message number you want to record. The controller will prompt you by saying "record message <number>," where number is the number you entered to record. After the prompt, key your radio and speak clearly to record the message. The recording is terminated when either you stop transmitting or the message slot is full (that is, the slot's message time is all used).

⇒ ***Note:*** Messages 0-95 (the pre-recorded vocabulary tracks) are write-protected by default to prevent accidental erasure or modification. If you want to change these tracks, then the write-protect switch needs to be turned off. See Section 4.9 for more information.

See Section 6.3 for the speech vocabulary table.

Example: To record tail message #1 (message # 100), send the following command with the controller unlocked: "*81 100". The controller will respond by saying "record message one hundred." Key your radio, and transmit your voice message. Recording ends either when you unkey, or the maximum message length for the message is reached, whichever comes first.

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*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 announce the software version and play the initial ID.

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4. Control Operator Commands

The NHRC-10 supports 80 different control operator settings arranged into 10 different groups of 8 "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. There are 10 groups of 8 items each.

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 speaking "control <group> point <item> is <state>", where group and item are the group and item numbers selected, and <state> is either of the words "enabled" or "disabled."

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 saying "control zero point zero is enabled."

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 to make your changes to the control operator switches be restored after a power failure, it is important that the controller's state be saved. See Section 3.4 for information on the save state command.

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4.1 Group 0 Switches: Repeater Control

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

Group 0 Switches:

Switch	Name	Description
0	Repeater Enable	This is the repeater's master enable/disable control. Set this to 0 to disable the repeater.
1	Repeater CTCSS Required	Allows the repeater to be set into a CTCSS required mode when enabled. When disabled, the repeater is carrier access. Note: If CTCSS Required **and** "dual squelch" mode are both selected, then the controller will require valid CTCSS for access, *unless the hang timer is running*. This mode allows the repeater to be activated by a user with the valid CTCSS tone, but then accessed by users without CTCSS, or to be activated with a 1750 Hz. tone for countries that require tone-burst access.
2	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 repeater will begin to repeat, but only when the transmitter is not on.
3	Hang Timer Enabled	Normally enabled, but can be disabled when the repeater runs on battery power, or to discourage "kerchunkers."
4	Hang Timer Select	Allows the control operator to select which hang timer value is used. Allows the long (1) or short (0) timer to be selected.
5	DTMF Access Mode Select	Allows the control operator to place the repeater into DTMF access mode. In DTMF access mode, the repeater, when idle, can only be activated by sending the DTMF access prefix, followed by a 1 to enable the repeater. The repeater will remain active until either disabled with the DTMF access prefix followed by a 0, or the repeater remains idle for longer than the time specified in the DTMF access timer.
6	Courtesy Tone Enabled	Allows the courtesy tone to be enabled or disabled.

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Group 0 Switches:

Switch	Name	Description
7	Control Operator CTCSS required	When this switch is enabled, control operator commands will only be accepted when the command is received with a valid CTCSS tone.

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4.2 Group 1 Switches: More Repeater Control

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

Group 1 Switches:

Switch	Name	Description
0	Repeater Time-out Timer Enable	Allows the time out timer on the main repeater to be enabled or disabled. Normally the time out timer will be enabled. However, certain applications may require the time-out timer be disabled. Set this switch to 1 to enable the repeater time-out timer.
1	Time Out Timer Long Select	Allows the long (1) or short (0) timer to be selected.
2	"Dual Squelch" Enable	Setting this switch to 1 enables dual squelch mode. In "Dual-Squelch" mode, either the CAS or the CTCSS signal will cause the repeater to be accessed. This is sometimes called "OR-Squelch" mode.
3	DTMF Muting Enable	Enables DTMF tone muting. When enabled (1), the controller will mute the receiver audio to prevent received DTMF command tones from being broadcast over the repeater.
4	Drop Link to Mute DTMF	When enabled (1), will cause the link transmitter to drop during the DTMF muting time, preventing linked repeaters from hearing dead air.
5	Patch requires CTCSS	When enabled (1), autopatch calls can only be made if the user is transmitting the valid CTCSS tone.
6	DTMF Pad Test Enable	When set (1), enables the DTMF pad test. (See Section 5.8 for a description of the DTMF pad test.)
7	Link Port Control Receiver Mode	If no control receiver is plugged in to the controller, the control receivers DTMF decoder is assigned to the link port. Setting this switch will cause the controller to mute DTMF tones received on the link port if DTMF muting (1.3) is enabled, and to immediately execute commands received on the link port when the link port CAS signal drops.

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4.3 Group 2 Switches: Voice ID and Tail Messages

Group 2 controls the voice ID and tail messages.

Group 2 Switches:

Switch	Name	Description
0	Enable Voice Initial ID	When enabled (1), the initial voice ID message is present. If disabled (0), the CWID will play instead of the voice initial ID.
1	Enable Normal ID #1	This switch enables Normal ID #1. If none of the normal ID messages are enabled, then the CW ID will be used instead of the voice ID. If more than one normal ID is enabled, then the enabled IDs will be rotated so all enabled normal ID messages will be played.
2	Enable Normal ID #2	This switch enables Normal ID #2. If none of the normal ID messages are enabled, then the CW ID will be used instead of the voice ID. If more than one normal ID is enabled, then the enabled IDs will be rotated so all enabled normal ID messages will be played.
3	Enable Normal ID #3	This switch enables Normal ID #3. If none of the normal ID messages are enabled, then the CW ID will be used instead of the voice ID. If more than one normal ID is enabled, then the enabled IDs will be rotated so all enabled normal ID messages will be played.
4	Enable Tail Message #1	This switch enables tail message #1. When the repeater tail drops the number of times specified by the tail message counter, one of the enabled tail messages will be played. If no tail messages are enabled, none will be played. If more than one tail message is enabled, the enabled tail messages will be rotated so all the tail messages will eventually be played.
5	Enable Tail Message #2	This switch enables tail message #2.
6	Enable Tail Message #3	This switch enables tail message #3.
7	Enable Mailbox Headers Tail Message	When enabled (1), will use the voice mailbox headers as a tail message, if any messages are present. The voice mailbox headers will be rotated in if other tail messages are enabled.

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4.4 Group 3 Switches: Miscellaneous Settings

Group 3 contains a variety of different settings that affect various parts of the controller's operation.

Group 3 Switches:

Switch	Name	Description
0	CI-V tune auto-receive mode	When enabled (1), will change the remote base into receive mode (as opposed to transmit) when a CI-V tune command (link-prefix 5 or link-prefix 9) command is executed. This feature is intended to prevent accidental operation outside of authorized band segments by forcing the operator to manually set transmit mode after the CI-V connected radio is tuned. Experienced users may want to disable this switch.
1	Allow ID Stomp by Keyup	When enabled (1), will allow the controller to cancel a voice ID and play the CW ID if a user begins to transmit while the voice ID is playing.
2	Enable Voice Time-out Message	When set (1), enables the voice time-out message, instead of the CW time-out message "TO."
3	Link Port Repeater Mode	When enabled (1), configures the link port as a slaved repeater. In this mode, the link port will have hang time and repeater IDs, it will transmit everything transmitted by the main repeater. When disabled, the link port works in link or remote base mode where the link transmit is only activated when a signal is received on the main repeater's input.
4	Digital Output/Fan Control	When enabled (1), configures the digital output on the main repeater connector to be a fan control output. A fan connected to this output will run while the transmitter is keyed, and a programmable amount of time after the transmitter is unkeyed. When disabled, the state of the fan control output is controlled by the Group 3 Item 5 switch.
5	Digital Output Control	When the Digital Output/Fan Control switch (Group 3 Switch 4) is disabled (0), this switch allows you to set the state of the fan control digital output on the main repeater connector. Setting this switch to 1 will turn on the active-low output, pulling it to ground.

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Group 3 Switches:

Switch	Name	Description
6	Main Repeater Port Digital Audio Delay Present	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on the main repeater port.
7	Link Port Digital Audio Delay Present	When enabled (1), changes the timing of the CAS logic in the controller to support the use of a NHRC-DAD on the link port.

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4.5 Group 4 Switches: Autopatch Configuration

Group 4 contains switches which configure the autopatch.

Group 4 Switches:

Switch	Name	Description
0	Enable Autopatch	Enables (1) or disables (0) the autopatch.
1	Enable Unrestricted Autopatch	Enables or disables the unrestricted autopatch. The unrestricted autopatch allows any telephone number to be entered. If the repeater's telephone line is restricted from making toll calls, 911 calls, etc., then this switch can be safely enabled. In other cases, care should be taken when enabling unrestricted autopatch.
2	Enable Autodial	Enables (1) or disables (0) the 100 autodial slots.
3	Enable Emergency Autodial	Enables (1) or disables (0) the 10 emergency autodial slots.
4	Disable Emergency Autodial Patch Timer	When set (1) disables the patch timer when the emergency autodials are used. ⇒ **Note: Use this switch with caution.** The user making the patch could drive out of the repeater's range, and the patch would not be hung up.
5	Enable Reverse Patch	When set (1), enabled the reverse patch command. The reverse patch command allows a repeater user to answer the ringing telephone, or a controlling user dialed into the repeater over the phone line to activate the patch remotely and talk over the repeater.
6	Enable Phone Ring Over Air	This switch, when set (1), will cause an audio tone to play over the main repeater whenever the telephone rings. ⇒ **Note:** Read the Part 97 FCC regulations carefully before you choose to do this.

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Group 4 Switches:

Switch	Name	Description
7	Enable Phone Answer	When enabled, allows the controller to answer the telephone after the number of rings specified in the phone ring counter has been received. This feature allows remote control of the repeater by telephone.

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4.6 Group 5 Switches: Link/Remote Base Port Configuration

Group 5 contains switches that configure the Link/Remote Base Port. Note that switches 0, 1, and 2 control the link state exactly the same as the Link/Remote Base prefix commands do. This allows the link state to be saved with saved controller setups.

Group 5 Switches:

Switch	Action	Description
0	Set Link Port Alert Mode	When enabled (1), configures the link port into "Alert Mode." In alert mode, a different courtesy tone is played when the main receiver drops if the link receiver is active. **Note:** The link audio is not repeated. Only the alert tone is present to indicate channel activity. This mode can be overridden by switch 1 or switch 2. This switch, as well as switches 1 and 2, can also be set with the link prefix. See Section 5.1.2 for more information on the link/remote base prefix.
1	Set Link Port Receive Mode	When enabled (1), configures the link port into "Receive Mode." In receive mode, the link port audio is transmitted over the main repeater, but the main repeater is not transmitted over the link port. This mode can be overridden by switch 2.
2	Set Link Port Transmit Mode	When enabled (1), configures the link port into "Transmit Mode." In this mode, the link receive audio is transmitted over the main repeater, and the main repeater's receive audio is transmitted over the link.
3	Enable Link Port During Patch	When enabled (1) will allow the link port to remain active during an autopatch. When disabled (0), autopatch activity will drop the link for the duration of the call.
4	Activate Link Prefix	When enabled (1), activates the link/remote base prefix. See Section 5.1.2 for more information on the link/remote base prefix.
5	Set CTCSS Access Mode	When enabled (1), the link port requires CTCSS. When disabled (0), the link port is carrier access.

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Group 5 Switches:

Switch	Action	Description
6	Link Port Dual Squelch Enable	When enabled (1), sets the link port to dual squelch mode.
7	Enable Link Port Time Out Timer	When enabled, the link port time-out timer is activated. **Note:** Normally the time-out timer will be enabled, however, certain applications may require the time-out timer to be disabled (linking on to another repeater, HF remote base, etc.).

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4.7 Group 6 Switches: Digital Output Port Configuration, etc.

Group 6 contains switches which configure the NHRC-10's optional 8-output digital output board.

Group 6 Switches:

Switch	Name	Description
0	Enable Pulsed Digital Output 1	When enabled (1), will cause digital output 1 to be automatically turned off ½ second after it is turned on, producing a ½ second pulse on the output.
1	Enable Pulsed Digital Output 2	When enabled (1), will cause digital output 2 to be automatically turned off ½ second after it is turned on, producing a ½ second pulse on the output.
2	Enable Pulsed Digital Output 3	When enabled (1), will cause digital output 3 to be automatically turned off ½ second after it is turned on, producing a ½ second pulse on the output.
3	Enable Pulsed Digital Output 4	When enabled (1), will cause digital output 4 to be automatically turned off ½ second after it is turned on, producing a ½ second pulse on the output.
4	Enable Pulsed Digital Output 5-8	When enabled (1), will cause each of digital output 5 through 8 to be automatically turned off ½ second after it is turned on, producing a ½ second pulse on the output.
5	Set Digital Outputs "One-of" Mode	When enabled (1), will set the digital outputs into a "one-of" mode. In this mode, turning on any output will first turn off all other outputs, producing a mode where only one output can be on at a time. (Hence, the term "one-of", since only one of eight outputs can be on at any time.)

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Group 6 Switches:

Switch	Name	Description
6	Drop PTT to mute DTMF.	When enabled (1), will cause the main transmitter to drop during the DTMF muting time, allowing DTMF to be repeated out the link port in a more secure fashion. This switch works in conjunction with the muting controls in Group 1 to allow flexible muting or DTMF retransmission applications. In order to send DTMF through the controller to the link radio, but not out the main repeater transmitter, group 6, switch 6 should be enabled (1) and group 1, switches 3 and 4 will need to be disabled.
7	Suppress Autopatch Phone Number Read Back.	When enabled (1) the controller will not read back telephone numbers prior to dialing.

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4.8 Group 7 Switches: Digital Output Port Control

Group 7 contains switches which directly control the outputs on the NHRC-10's optional 8-output digital output.

Group 7 Switches:

Switch	Name	Description
0	Enable Digital Output 1 Control	When enabled (1), turns on digital output 1. When disabled (0), turns off digital output 1.
1	Enable Digital Output 2 Control	When enabled (1), turns on digital output 2. When disabled (0), turns off digital output 2.
2	Enable Digital Output 3 Control	When enabled (1), turns on digital output 3. When disabled (0), turns off digital output 3.
3	Enable Digital Output 4 Control	When enabled (1), turns on digital output 4. When disabled (0), turns off digital output 4.
4	Enable Digital Output 5 Control	When enabled (1), turns on digital output 5. When disabled (0), turns off digital output 5.
5	Enable Digital Output 6 Control	When enabled (1), turns on digital output 6. When disabled (0), turns off digital output 6.
6	Enable Digital Output 6 Control	When enabled (1), turns on digital output 6. When disabled (0), turns off digital output 6.
7	Enable Digital Output 7 Control	When enabled (1), turns on digital output 7. When disabled (0), turns off digital output 7.

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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:

Switch	Name	Description
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	Write Protect Patch Setup	When enabled (1), causes the *4, Program Autopatch Restrictions command to fail, effectively disallowing modification of the autopatch restrictions.
4	Write Protect Autodials	When enabled (1), causes the *5, Program Autodial Slots command to fail, effectively disallowing modification of the autodial memories.
5	Reserved	Reserved for NHRC
6	Write Protect CW Messages and Courtesy Tones	When enabled (1), causes the *70 and *71 commands to fail when new messages are specified, effectively disallowing modification of the CW ID and courtesy tones.
7	Write Protect Pre-recorded Vocabulary Tracks	When enabled (1), causes the *81 "record voice message" command to fail when any of the pre-recorded vocabulary tracks (0-95) are specified, effectively disallowing modification of these tracks.

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4.10 Group 9 Switches: Control Operator Group Access

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

Group 9 Switches:

Switch	Name	Description
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.

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5. User Commands

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

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 Autopatch

This command allows repeater users to make telephone calls through the repeater system. The autopatch command implements the rules set by the Autopatch Restrictions, so only area codes and exchanges authorized by the repeater operator can be called. (See Section 3.7 for information on programming autopatch restrictions.)

The format of the autopatch command is:

<prefix><phone-number> where:

<prefix> is the autopatch prefix as programmed by the repeater operator.

<phone-number> is the number to dial. 7-, 8-, 10-, or 11-digit phone numbers are checked against the patch restrictions, and dialed if the area code and exchange are valid. No other numbers can be dialed with the autopatch.

Example: If the autopatch prefix is set to 456, and you want to dial number 202-555-1234, send the following command: "456 2025551234". If the 202 area code is enabled, and the 555 exchange in the 202 area code is also enabled, then the controller will say "autopatch two zero two five five five one two three four," and then dial the phone. If the area code and/or exchange is not enabled, then the controller will say "bad phone number," and the call will not be placed. The phone number read back can be suppressed by briefly keying your mike while the number is being read back.

The autopatch call will remain active until either the autopatch timer times out, or the user sends the hang-up code. Shortly before the autopatch timer times out, the controller will begin sending short beeps over the air to indicate the imminent timeout. The autopatch timer can be reset by transmitting the autopatch prefix.

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5.2 Unrestricted Autopatch

This command allows repeater users to make telephone calls through the repeater system. The unrestricted autopatch command allows *any* phone number to be called. It is not affected by the Autopatch Restrictions.

The format of the unrestricted autopatch command is:

<prefix><phone-number> where:

<prefix> is the autopatch prefix as programmed by the repeater operator.

<phone-number> is the number to dial. Any number is valid.

⇒ **Caution:** NHRC suggests caution in the use of the unrestricted autopatch and the distribution of the prefix if your repeater's telephone line does not have a toll restriction from the telephone company on it. There is no protection from patch users making any kind of long-distance calls with the unrestricted autopatch. If you do not want to use this feature at all, disable the unrestricted autopatch by setting control operator group 4 item 1 to 0 (disabled), and programming a long sequence (7 digits) for the prefix.

Example: If the autopatch prefix is set to 987, and you want to dial number 202-555-1234, send the following command: "987 2025551234". The controller will say "autopatch two zero two five five five one two three four," and then dial the phone. The phone number read back can be suppressed by briefly keying your mike while the number is being read back.

The autopatch call will remain active until either the autopatch timer times out, or the user sends the hang-up code. Shortly before the autopatch timer times out, the controller will begin sending short beeps over the air to indicate the imminent timeout. The autopatch timer can be reset by transmitting the unrestricted autopatch prefix.

Note: When the patch is initiated, the controller will read back the dialed number. If you do not want to hear the dialed number, you can "click" your mike PTT to stop the read back, or the phone number read back can be suppressed by setting control operator group 6, switch 7 to 1. See section 4.7 for information about this switch.

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5.3 Autodial

The NHRC-10 Repeater Controller supports 250 autodial memory locations, or "slots." The repeater operator can program the slots with the *5 command. See Section 3.5 for information on programming the autodial slots.

Users can make telephone calls using their assigned autodial slots with the following command:

<prefix><slot-number> where:

<prefix> is the autodial prefix as programmed by the repeater operator, described in Section 3.5 of this manual.

<slot-number> is the autodial slot number to dial. The valid range for autodial slot number is 0-249.

Example: If the autodial prefix is set to 34, to call the number stored in autodial slot #123, send the following command: "34 123". If a phone number is stored in that slot, then the controller will say "autodial one hundred twenty three," and the call will be placed. If the specified slot is not programmed, then NO ERROR MESSAGE WILL BE PLAYED.

The autopatch call will remain active until either the autopatch timer times out, or the user sends the hang-up code. Shortly before the autopatch timer times out, the controller will begin sending short beeps over the air to indicate the imminent timeout. The autopatch timer can be reset by transmitting the autodial prefix.

Note: When the patch is initiated, the controller will read back the dialed number. If you do not want to hear the dialed number, you can "click" your mike PTT to stop the read back, or the phone number read back can be suppressed by setting control operator group 6, switch 7 to 1. See section 4.7 for information about this switch.

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5.4 Emergency Autodial

The NHRC-10 Repeater Controller supports 10 emergency autodial memory locations, or "slots." The repeater operator can program the slots with the *5 command. See section 3.5 for information on programming the autodial slots.

Users can make emergency telephone calls to the pre-assigned emergency autodial slots with the following command:

<prefix><slot-number> where:

<prefix> is the autodial prefix as programmed by the repeater operator, described in Section 3.5 of this manual.

<slot-number> is the emergency autodial slot number to dial. The valid range for autodial slot number is 0-9.

Example: if the emergency autodial prefix is set to 12, to call the number stored in emergency autodial slot #6, send the following command: "126". If a phone number is stored in that slot, then the controller will say "emergency autodial six", and the call will be placed. If the specified slot is not programmed, then NO ERROR MESSAGE WILL BE PLAYED.

5.5 Patch Hang Up Code

The NHRC-10 Autopatch Hang-up Code is programmable to prevent miscreants from using the default "#" to hang up user's telephone calls.

Whether the hang-up code is the default "#", or changed to some other prefix, the use is the same:

<prefix> where:

<prefix> is the hang-up prefix as programmed by the repeater operator, described in Section 3.5 of this manual.

Example: To hang up the patch if the patch hang up code is "#", send "#". To hang up the patch if the patch hang up code is 4321, then send "4321".

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5.6 DTMF Access

The NHRC-10 Repeater Controller supports a DTMF access mode, which allows the repeater to be left in a secured disabled state, but users who know the DTMF access code can enable the repeater. The repeater reverts to the secured disabled state when either the repeater is idle for longer than the DTMF access mode timer, or a user sends the DTMF access code followed by a zero.

The repeater is put into DTMF access mode by setting control operator group 0, item 5 to enabled (1). See section 4.1 for information about this control operator switch, and 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 "567 0".

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5.7 Re-transmit DTMF

The NHRC-10 has the capability to re-transmit DTMF tones for various control and paging applications. The re-transmitted tones could be used to control a linked repeater, change the frequency of a remote link, activate DTMF-coded squelch on a user's radio, or send control sequences to a NHRC-Remote Intelligent DTMF remote control.

To retransmit DTMF over the repeater, send the following command:

<prefix><DTMF-sequence> where:

<prefix> is the Re-Transmit DTMF prefix.

<DTMF-Sequence> is the DTMF sequence to re-transmit.

Example: If the Retransmit DTMF prefix is set to 44, and you want to cause the repeater to send "765*123", send the following command "44 765*123". After you unkey, the repeater will send the specified DTMF string.

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5.8 DTMF Pad Test

The NHRC-10 supports a DTMF pad test. This test serves several purposes: It shows that the user's DTMF pad is working, that the RF link is of sufficient quality to support DTMF signaling, and that the controller's DTMF receivers are working.

Testing a DTMF pad involves sending the DTMF Pad Test prefix, followed by up to 15 DTMF tones. The controller will read back the tones received, substituting "E" for the * key and "F" for the "#" key.

To use the DTMF Pad Test, send the following command:

<prefix><DTMF-sequence> where:

<prefix> is the re-transmit DTMF prefix.

<DTMF-Sequence> is a sequence of DTMF tones to test.

Example: If the DTMF Pad Test prefix is 54, you can test your DTMF pad by sending "54 1234567890*#". The controller will respond by saying "one two three four five six seven eight nine zero e f".

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5.9 Reverse Patch

The NHRC-10 supports reverse patch functionality to allow a user to call the repeater over the telephone, then enable the phone patch so the telephone is linked into the repeater.

The reverse patch can be activated when either of two things happen:

- The telephone is ringing, and a repeater user, hearing the ringing tone, activates the reverse patch, or,
- A user calls the repeater, the repeater answers in the control mode, and that user sends the reverse patch command over the telephone.

In either case, the patch is ended when either the autopatch timer times out, or the patch hang-up code is received from either the telephone, or over the repeater.

The reverse patch is initiated as follows:

<prefix> where:

<prefix> is the reverse patch prefix as programmed by the repeater operator.

Examples:

If the reverse patch prefix is 5432, and a control operator calls the repeater controller over the phone, after the controller answers, the control operator can send 5432 over the phone. After the two-second DTMF inter-digit timer expires, the command will be evaluated, and the control operator will be connected through the autopatch to the repeater. Note that the controller must have "reverse patch enabled" (control operator group 4 switch 5), "phone answer enabled" (control operator group 4 switch 7), and the phone ring counter (timer 12) must be set to a non-zero value.

In another, similar example, if a control operator hears the phone ringing over the air ("Reverse Patch Rings Out Over Air", control operator group 4 switch 6 must be enabled), then the control operator can send "5432" over the air to the repeater to answer the phone. Carefully consult Part 97 before using this feature.

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5.10 Digital Output Control

The NHRC-10 supports the *optional* NHRC-10-DOUT 8-output digital control board. This board adds 8 digital outputs to the controller. These digital outputs can be controlled with the Digital Output Control prefix.

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

<prefix><output number><state> where:

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

<output number> is the output port you want to check or set, from 0 to 7 .

<state> Optional; is the on (1) or off (0) state you want to set the port to. Must be 0 or 1. Do not enter the state digit to inquire the current port state

Example: Assuming the Digital Output Control prefix is 99 and you want to turn on output 2, you can send "9921" to the controller. The controller will respond "two is on." If you want to check whether port 5 is on or off, you can send "995" to the controller. It will either respond with "five is on" or "five is off."

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5.11 Voice Mailbox

The NHRC-10 supports six voice mailboxes. The system handles the voice mailboxes in a fashion compatible with the ACC (Advanced Computer Controls) DVR. It allows voice messages to be stored and retrieved by any user who knows the voice mailbox prefix (as programmed by you.)

The voice mailbox can be used for a variety of applications, from something as simple as a lunch announcement, to detailed user-to-user messages. Users can save, retrieve, and delete messages with simple DTMF sequences.

Each message can be as long as 32 seconds. To save user time and simplify access, each message has a number (1 through 6) and a header (a short introduction or title… not more than 8 seconds.) When you want to check for messages, you send the voice mailbox prefix. The controller will respond with the message number and header of each recorded message. When you hear a message header that interests you, you request that message specifically (by number.)

Recording and deleting messages is not much different that playing them. The controller manages the message numbering, placing each new message in the next available slot. If you should try recording when all mailbox slots are full, the controller simply replies "no message".

Instructions and examples for playing, recording, and deleting voice mailbox messages are given in this section.

5.11.1 Play the voice mailbox headers

The voice mailbox headers can be played by entering the voice mailbox prefix alone.

<prefix> where:

<prefix> is the voice mailbox prefix as programmed by the repeater operator.

The controller will say "message," and then the message number and message header for each mailbox in use.

If no mailboxes are in use, then the controller will say "no mailbox message."

Example: Assuming the Voice Mailbox prefix is 765, you can play the message headers by sending "765" to the controller. The controller will announce the message number and the message header for each voice mailbox message stored, for instance:

"one" (contents of message header 1)
"two" (contents of message header 2)

…for up to six messages.

5.11.2 Play a specific message

To play a particular message, use the following command

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<prefix><message-number> where:

<prefix> is the voice mailbox prefix as programmed by the repeater operator.

<message-number> is the number spoken by the controller before the message header is played. The valid range is 1 to 6; however, only messages that are present may be played.

After the command is received, the controller will play the message header and contents. If there is no message for the specified message number, the controller will say "no mailbox <message-number>."

Example: Assuming the Voice Mailbox prefix is 765, you can play message number 2 by sending "765 2" to the controller. The controller will play the message header, then the message body for message number 2.

5.11.3 Record a message

To record a message, enter the following command:

<prefix>* where:

<prefix> is the voice mailbox prefix as programmed by the repeater operator.

The controller will say "record message header." The user should transmit a brief description of the message, who it is for, what it is about, etc. The message header can hold up to eight seconds of speech. The controller will then say "record mailbox message." The user should now transmit the message to be recorded. The mailbox message can be up to 32 seconds. After the message is recorded, the controller will say "OK."

Example: Assuming the Voice Mailbox prefix is 765, you can record a voice mailbox message with the following procedure:

Send "765 *" to the controller. Unkey. The controller will say "record message header." Key up and say the words you want for the message header, then unkey. The controller will say "record mailbox message." Key up again, and say the message you want stored in the mailbox. Unkey. The controller will say "OK."

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5.11.4 Delete the last message played

The last message played can be deleted by sending the following command:

<prefix>** where:

<prefix> is the voice mailbox prefix as programmed by the repeater operator.

The controller will respond with “OK.”

Example: Assuming the Voice Mailbox prefix is 765, you can delete the voice mailbox message that was last played by sending the command “765 **”. The controller will respond with “OK.”

5.11.5 Perform an audio check

The NHRC-10 supports an “audio check” feature. This allows repeater users to hear what they sound like over the repeater. This feature is particularly useful to check signal quality into the repeater prior to making a phone patch.

When the audio check prefix is received, the controller will say “record test message.” At this point, the user will transmit their test message. Immediately after the users test transmission ends, the repeater will play back the user’s test message. The audio check feature will record up to eight seconds of audio for the test message.

The audio check feature can be accessed with the voice mailbox prefix as follows:

<prefix>*** where:

<prefix> is the voice mailbox prefix as programmed by the repeater operator.

Example: Assuming the Voice Mailbox prefix is set to "765":
Send the command “765 ***”. The controller will respond "record test message." Now key your radio again and speak. The controller will record and play back up to the first eight seconds of your voice, so you can hear how you sound.

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5.12 Link/Remote Base

The NHRC-10 Repeater Controller supports a link/remote base radio which can be used as a link to another repeater system, a "slaved" repeater, or a remote base. The link/remote base prefix is used to control the state of the remote base port. The remote base port can be configured into four different modes:

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

The link/remote base port can be configured to automatically shut off after a programmable idle period. (The auto shutoff timer only works when the link/remote base port is in the receive or transmit mode, it does not apply to alert mode.) Timer 13 sets the auto shutoff idle time. The link/remote base idle timer is reset by channel activity on the repeater. If you do not want to use the link/remote base auto-shutoff mode, program timer 13 to 0. See section 3.6.1 for information on programming the controller's timers. This feature can be used to make sure your HF remote base is disabled if you drive out of range of the repeater.

5.12.1 Select remote base operating mode

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

<prefix><mode> where:

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

<mode> is the remote base operating mode.

Remote Base Operating Modes

Mode	Description
0	off
1	alert mode
2	receive mode
3	transmit mode
Remote Base CI-V Control :	
4	CI-V mode select
5	CI-V frequency select
6	CI-V VFO/Memory select
7	CI-V Memory Channel Select
8	CI-V Split Mode Select
9	CI-V fine tune mode

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The NHRC-10 remote base supports the Icom® CI-V protocol to control an Icom® IC-706 Mk II G or similar radio as a frequency-agile remote base. Six additional commands on the prefix support the mode control (AM, FM, USB, LSB), tuning, memory channels, and split operation.

5.12.2 Set or check transceiver mode

To set or check the mode of the attached transceiver, use the following command:

<prefix>4<mode-digit> where:

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

4 is the select mode sub-command

<mode-digit> is the mode select digit, from the table below.

If mode-digit is not specified, the controller will poll the transceiver and report the mode ("upper sideband") currently selected.

mode-digit	Mode
0	LSB
1	USB
2	AM
3	FM

5.12.3 Set or check transceiver frequency

To set or check the frequency of the attached transceiver, use the following command:

<prefix>5<frequency> where:

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

5 is the set/check frequency sub-command.

<frequency> frequency is the frequency to tune the transceiver to. The format of the frequency is gmmM*Kkkhhh, where g represents the GHz digit, m/M represent the MHz digits, * represents the decimal point, k/K represent the KHz digits, and h represents the Hz digits. At least one MHz and one KHz digit must be specified, with the * between them to represent the decimal point. For example, to tune the attached transceiver to 14.303 MHz, the command would be "<prefix>514*303".

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If frequency is not specified in the command, then the controller will poll the transceiver and report it's current frequency ("fourteen point three zero three").

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5.12.4 Select transceiver memory or VFO mode

To select Memory or VFO mode, or to select the transceiver's current VFO, use the VFO command:

<prefix>6<vfo-digit> where:

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

6 is the select VFO sub-command.

<vfo-digit> is the VFO select digit, from the table below.

VFO-Digit	Operation
0	select memory mode
1	select VFO mode.
2	select VFO A
3	select VFO B
4	make other VFO equal this VFO (A=B)
5	swap with other VFO (A/B)

5.12.5 Select a transceiver memory channel

To select a memory channel, use the following command:

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

7 is the select memory channel sub-command.

<mem-channel> is a 1- or 2-digit number from 0 to 99 that represents the memory channel you want to select.

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5.12.6 Select transceiver split frequency operation

To select split (separate transmit and receive frequencies) use the following command:

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

8 is the split mode sub-command.

<split-digit> is the split mode control digit:

Split-Mode Sub-Commands:

split-digit	split mode
0	split off
1	split on

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5.12.7 DTMF adjustment of operating frequency

SSB operations are rarely directly on the frequency originally tuned. The NHRC-10 CI-V interface supports a fine-tune mode to allow the transceiver frequency to be finely adjusted. To enter the fine-tune mode, enter the following command:

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

9 is the tune mode select sub-command.

When in tune mode, received DTMF digits will adjust the transceiver's frequency. Consult the Tune Mode DTMF Mapping table, below, for each keys' action.

Tune Mode DTMF Key Mapping

1 +100 KHz	**2** +10 KHz	**3** +1 KHz	**A** +100 Hz
4 –100 KHz	**5** –10 KHz	**6** –1 KHz	**B** –100 Hz
7 Scan Tune	**8** +10 Hz	**9** -10 Hz	**C** Link Receive
*** Frequency Control	**Ø** Mode Control	**#** Exit Tune Mode	**D** Link Transmit

The 1, 2, 3, A and 8 keys increase the tuned frequency.

The 4, 5, 6, B and 9 keys decrease the tuned frequency.

The 7 key, followed by one of 1, 2, 3, A, 8, 4, 5, 6, B, or 9 will start continuously changing the frequency tuned by adjusting the frequency by the indicated step key. The controller will stop changing frequency when the main receiver unsquelches. (For instance, if the user "clicks" his microphone PTT switch." Every time the 100 Khz digit is changed (by carrying from or borrowing to the 10 KHz digit) the controller will emit a beep tone.

The * key allows frequency entry, just like the 5 subcommand. If just * is sent, the controller will read back the transceiver's tuned frequency, otherwise the entered frequency is tuned.

The 0 key allows mode control, just like the 4 subcommand. If just 0 is sent, then the transceiver's mode is read back, otherwise the indicated mode is selected.

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The C key will select link receive mode, just like the 2 subcommand: the remote base will not transmit, only listen.

The D key will select link transmit mode, just like the 3 subcommand: the remote base will transmit everything received by the repeater.

Tune mode is exited by sending the # key.

Example: Assuming the link prefix is "123":

Send "123 9" to enter tune mode.
Send "*28*500" to tune to 28.500 MHz.
Send "73" to begin "scanning" up by 1KHz increments.
When the radio is tuned to 28.600 MHz, the controller will emit a beep tone.
When an interesting signal is received, click your microphone to stop scanning.
Send the "*" command to have the controller read back the frequency tuned.
Send the 6, B, 9, 3, A, and/or 8 keys to fine tune the signal
Send the D key to enable transmit mode.

Caution:

Scan mode can tune the radio out of your authorized bands. Use care to avoid transmitting in an unauthorized segment. Use of the CI-V tune auto-receive mode (control operator group 3 switch 0) can help prevent transmitting on unauthorized frequencies, since it requires the transmitter to be specifically enabled after any tuning operation. See section 4.4 for information about the CI-V tune auto-receive mode.

5.13 Load Saved Setup

The NHRC-10 supports five saved setups of all 80 control operator switches. (See 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 from 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 #3, send "314159 3". The controller will respond "OK".

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5.14 LiTZ

The NHRC-10 supports the LiTZ standard. LiTZ stands for Long Tone Zero, which is a DTMF zero tone is received for more than two seconds continuously.

The LiTZ protocol is used to indicate emergency traffic or some other kind of emergency condition.

When a LiTZ is received, or the LiTZ prefix is entered, the controller will play the LiTZ message, message #115.

NHRC suggests programming the LiTZ prefix to "911," and programming the LiTZ message with information about use of the emergency autodials or information about using another repeater system to get help in an emergency situation.

To activate the LiTZ message, either the long tone zero or the LiTZ prefix can be sent:

<prefix> where:

<prefix> is the LiTZ prefix as programmed by the repeater operator.

Example: If you transmit the zero DTMF tone for three seconds, the controller will play the LiTZ/911 track.

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6. Appendices

6.1 Factory Defaults

6.1.1 Default command prefixes table

Index	Description	Default Prefix
00	Control Operator	00
01	Autopatch	01
02	Unrestricted Autopatch	02
03	Autodial	03
04	Emergency Autodial	04
05	Patch Hang Up	#
06	DTMF Access	06
07	Retransmit DTMF	07
08	DTMF test	08
09	Reverse Patch	09
10	Digital Output Control	10
11	Voice Mailboxes	11
12	Remote Base	12
13	LiTZ Message	911
14	Load Saved Setup	14
15	Unlock Controller	15

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6.1.2 Timer defaults table

Timer Number	Description	Multiplier	Timer Value	Effective Value
00	hang timer long	.1	100	10.0
01	hang timer short	.1	50	5.0
02	ID timer	10	54	540
03	patch timer	10	18	180
04	autodial timer	10	18	180
05	emergency autodial timer	10	30	300
06	DTMF access timer	10	60	600
07	time-out timer long	1	240	240
08	time-out timer short	1	30	30
09	DTMF mute timer	.1	20	2.0
10	fan timer	10	12	120
11	tail message counter	1	0	0
12	phone ring counter	1	0	0
13	link/remote base auto shutoff timer	10	0	0

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6.1.3 Courtesy tone component tones table

Tone Code	Tone
00	DTMF 0 tone
01	DTMF 1 tone
02	DTMF 2 tone
03	DTMF 3 tone
04	DTMF 4 tone
05	DTMF 5 tone
06	DTMF 6 tone
07	DTMF 7 tone
08	DTMF 8 tone
09	DTMF 9 tone
10	DTMF A tone
11	DTMF B tone
12	DTMF C tone
13	DTMF D tone
14	DTMF * tone
15	DTMF # tone
16	Note D#5
17	Note E5
18	Note F5
19	Note F#5
20	Note G5
21	Note G#5
22	Note A5
23	Note A#5
24	Note B5
25	Note C6
26	Note C#6
27	Note D6
28	Note D#6
29	Note E6
30	Note F6
31	Note F#6

Tone Code	Tone
32	Note G6
33	Note G#6
34	Note A6
35	Note A#6
36	Note B6
37	Note C7
38	Note C#7
39	Note D7
40	Note D#7
41	Modem 1300
42	Modem 2100
43	Modem 1200
44	Modem 2200
45	Modem 980
46	Modem 1180
47	Modem 1070
48	Modem 1270
49	Modem 1650
50	Modem 1850
51	Modem 2025
52	Modem 2225
53	DTMF row 1
54	DTMF row 2
55	DTMF row 3
56	DTMF row 4
57	DTMF column 1
58	DTMF column 2
59	DTMF column 3
60	DTMF column 4
61	No tone
62	No tone
63	No tone

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6.1.4 CW ("morse code") character table

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

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6.2 Control Operator Controls

6.2.1 Control operator group 0 (repeater control) operations table

Group #	Item #	Function	Default	Comments
0	**0**	Repeater Enable	1	
0	**1**	Repeater CTCSS required	0	
0	**2**	key up delay (kerchunk filter)	0	
0	**3**	Hang Timer Enabled	1	
0	**4**	Hang timer short/long select	0	0=short, 1=long, see related timer values.
0	**5**	DTMF access mode	0	see related DTMF access code and timer information
0	**6**	courtesy tone enabled	1	
0	**7**	Control op CTCSS required	0	

6.2.2 Control operator group 1 (repeater control II) operations table

Group #	Item #	Function	Default	Comments
1	**0**	repeater time out timer enable	1	see related timer value
1	**1**	time out long / short	1	0=short, 1=long, see related timer values short time-out
1	**2**	Enable “dual squelch”	0	allows CTCSS or CAS to provide valid CAS
1	**3**	Enable DTMF Muting	1	Repeater mutes touch tones
1	**4**	Drop link to mute DTMF	0	
1	**5**	Patch requires CTCSS	0	
1	**6**	DTMF pad test enable	1	see DTMF pad test prefix
1	**7**	Control Receiver is Link Port	0	Set to 1 when control receiver gets link receiver audio

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6.2.3 Control operator group 2 (voice and tail ID messages) operations table

Group #	Item #	Function	Default	Comments
2	**0**	Enable Voice Initial ID	1	Plays CW ID if disabled. See CWID programming
2	**1**	Enable Normal ID #1	0	If no normal id enabled, CW ID is used
2	**2**	Enable Normal ID #2	0	If no normal id enabled, CW ID is used
2	**3**	Enable Normal ID #3	0	If no normal id enabled, CW ID is used
2	**4**	Enable Tail message #1	0	
2	**5**	Enable Tail message #2	0	
2	**6**	Enable Tail message #3	0	
2	**7**	Enable Mailbox Tail Message	0	Will play message headers when present.

6.2.4 Control operator group 3 (miscellaneous settings) operations table

Group #	Item #	Function	Default	Comments
3	**0**	CI-V tune auto-receive mode	0	Allows either tune mode (subcommands 5 and 9) to automatically select link receive mode
3	**1**	Allow ID Stomp by key up	1	ID reverts to CW when keyed over.
3	**2**	Enable voice time out message	1	Plays CW “TO” when disabled.
3	**3**	Link port repeater mode	0	remote base port is slaved full duplex port if 1
3	**4**	Digital output/Fan Control	0	0=digital output, 1=fan control
3	**5**	Digital output control	0	1=on, 0=off
3	**6**	Delay present main port	0	NHRC-DAD installed on repeater.
3	**7**	Delay present secondary port	0	NHRC-DAD installed on remote base.

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6.2.5 Control operator group 4 (autopatch configuration) operations table

Group #	Item #	Function	Default	Comments
4	**0**	Autopatch enabled	1	
4	**1**	Unrestricted Autopatch enabled	1	
4	**2**	Autodial Enabled	1	
4	**3**	Emergency Autodial Enabled	1	
4	**4**	Emergency Autodial Timer Disable	1	
4	**5**	Reverse Patch Enabled.	1	
4	**6**	Reverse Patch Rings out over air.	1	
4	**7**	Phone Answer Enabled.	1	

6.2.6 Control operator group 5 (link port configuration) operations table

Group #	Item #	Function	Default	Comments
5	**0**	Link Port Alert Mode	0	See Prefix #12.
5	**1**	Link Port Monitor Mode	0	Supercedes item 0. See Prefix # 12
5	**2**	Link Port TX Mode	0	Supercedes item 0 & 1. See Prefix # 12
5	**3**	Link Port enabled during patch	0	Remote base drops during patch / back on after patch
5	**4**	Link Prefix Enable	1	Allows link prefix (prefix #12) to control link.
5	**5**	Link Port CTCSS required	0	
5	**6**	Link Port “Dual Squelch”	0	
5	**7**	Link Port time out timer enable	0	

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6.2.7 Control operator group 6 (digital output port configuration, etc.) operations table

Group #	Item #	Function	Default	Comments
6	**0**	Digital output 1 is pulsed	0	
6	**1**	Digital output 2 is pulsed	0	
6	**2**	Digital output 3 is pulsed	0	
6	**3**	Digital output 4 is pulsed	0	
6	**4**	Digital outputs 5,6,7,8 are pulsed	0	
6	**5**	Digital outputs “one-of” mode	0	
6	**6**	Drop main PTT to mute DTMF	0	
6	**7**	Suppress autopatch number readback.	0	

6.2.8 Control operator group 7 (digital output port control) operations table

Group #	Item #	Function	Default	Comments
7	**0**	Digital out 1 control	0	
7	**1**	Digital out 2 control	0	
7	**2**	Digital out 3 control	0	
7	**3**	Digital out 4 control	0	
7	**4**	Digital out 5 control	0	
7	**5**	Digital out 6 control	0	
7	**6**	Digital out 7 control	0	
7	**7**	Digital out 8 control	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**	write protect patch setup	0	
8*	**4**	write protect autodials	0	
8*	**5**	(reserved)	0	
8*	**6**	write protect CW messages & courtesy tones	0	
8*	**7**	write protects pre-recorded vocabulary tracks	1	Protects tracks 0-95 against accidental modification

6.2.10 Control operator group 9 (control operator group access) operations table

Group #	Item #	Function	Default	Comments
9*	**0**	enable access to group 0	1	
9*	**1**	enable access to group 1	1	
9*	**2**	enable access to group 2	1	
9*	**3**	enable access to group 3	1	
9*	**4**	enable access to group 4	1	
9*	**5**	enable access to group 5	1	
9*	**6**	enable access to group 6	1	
9*	**7**	enable access to group 7	1	

* controller must be unlocked to access groups 8 and 9

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6.3 Speech Vocabulary Table

Message Number	Message Length	Message Content
0	1.0	zero
1	1.0	one
2	1.0	two
3	1.0	three
4	1.0	four
5	1.0	five
6	1.0	six
7	1.0	seven
8	1.0	eight
9	1.0	nine
10	1.0	ten
11	1.0	eleven
12	1.0	twelve
13	1.0	thirteen
14	1.0	fourteen
15	1.0	fifteen
16	1.0	sixteen
17	1.0	seventeen
18	1.0	eighteen
19	1.0	nineteen
20	1.0	twenty
21	1.0	thirty
22	1.0	forty
23	1.0	fifty
24	1.0	sixty
25	1.0	seventy
26	1.0	eighty
27	1.0	ninety
28	1.0	hundred
29	1.0	thousand
30	1.0	access
31	1.0	autopatch

Message Number	Message Length	Message Content
32	1.0	bad
33	1.0	base
34	1.0	call
35	1.0	complete
36	1.0	control
37	1.0	command
38	1.0	disabled
39	1.0	denied
40	1.0	enabled
41	1.0	error
42	1.0	frequency
43	1.0	is
44	1.0	hertz
45	1.0	kilo
46	1.0	link
47	1.0	mega
48	1.0	message
49	1.0	minus
50	1.0	minutes
51	1.0	off
52	1.0	on
53	1.0	operator
54	1.0	phone
55	1.0	PL
56	1.0	point
57	1.0	program
58	1.0	receive
59	1.0	record
60	1.0	no
61	1.0	remote
62	1.0	repeater
63	1.0	ring

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6.3 Speech Vocabulary Table (Continued)

Message Number	Message Length	Message Content
64	1.0	seconds
65	1.0	squelch
66	1.0	timer
67	1.0	transmit
68	1.0	test
69	1.0	NHRC
70	1.0	mailbox
71	1.0	controller
72	1.0	version
73	1.0	emergency
74	1.0	autodial
75	1.0	OK
76	1.0	sideband
77	1.0	AM
78	1.0	PM
79	1.0	upper
80	1.0	lower
81	1.0	FM
82	1.0	A
83	1.0	B
84	1.0	C
85	1.0	D
86	1.0	E
87	1.0	F
88	1.0	meters
89	1.0	centi
90	1.0	alert
91	1.0	up
92	1.0	down
93	1.0	plus
94	1.0	number
95	1.0	header
96	8.0	normal ID 1

Message Number	Message Length	Message Content
97	8.0	normal ID 2
98	8.0	normal ID 3
99	8.0	time-out message
100	8.0	(reserved)
101	8.0	(reserved)
102	8.0	(reserved)
103	8.0	test track
104	8.0	courtesy tone msg.
105	8.0	mbox 1 header
106	8.0	mbox 2 header
107	8.0	mbox 3 header
108	8.0	mbox 4 header
109	8.0	mbox 5 header
110	8.0	mbox 6 header
111	32.0	initial ID message
112	32.0	tail message 1
113	32.0	tail message 2
114	32.0	tail message 3
115	32.0	litz message
116	32.0	(reserved)
117	32.0	mbox 1 contents
118	32.0	mbox 2 contents
119	32.0	mbox 3 contents
120	32.0	mbox 4 contents
121	32.0	mbox 5 contents
122	32.0	mbox 6 contents

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7. Terminology and Abbreviations

Term	Description
Autodial	An abbreviation for “Automatic Dial” where telephone numbers pre-loaded into numbered memory slots on the controller and are dialed (“autodialed”) by the controller when their address is specified using an autodial prefix and slot-number.
Autopatch	An abbreviation for “Automatic Phone Patch” which allows users possessing the “autodial” prefix code to make telephone calls from the repeater.
CAS	Carrier Activated Squelch, where receipt of a signal, with or without CTCSS tones will activate the controller.
CI-V	“Computer Interrface V (Five)” as specified by the Icom® Manufacturing Co. for use with their radio equipment.
CODEC	A term used for an “enCODer / dECoder.”
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
LiTZ	An abbreviation for “Long Dial Tone Zero” in which 2 or more seconds of the DTMF digit zero will activate special functions in the controller.
PTT	Push-to-Talk

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

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8. Circuit Board

8.1 Interconnections

Connector	Name	Purpose
J1	"Repeater"	Connects the main repeater transmit and receive audio, PTT, CAS, fan control, and CTSS encode/decode signals to the controller.
J2	"Remote Base"	Connects the remote base transmit and receive audio, PTT, CAS, and CTSS encode/decode signals to the controller.
J3	"Main Delay"	Connects power and audio signals for operation of the Digital Audio Delay (DAD) board for the main repeater to the controller.
J4	"Remote Base Delay"	Connects power and audio signals for operation of the Digital Audio Delay (DAD) board for the remote base to the controller.
J5	"CI-V" Interface"	Connects a CI-V protocol enabled radio to the controller.
J6	"Control Receiver"	Connects the control receiver audio to the controller.
J7	"Power"	Connects +12V DC power to the controller.
J12	"Main Accy"	Allows interfacing CTCSS decoder or NHRC-Squelch for the main repeater inside the controller cabinet.
J13	"RB Accy"	Allows interfacing CTCSS decoder or NHRC-Squelch for the remote base inside the controller cabinet.

The following page is a detailed top view of the Revision "B" printed wiring board for the NHRC-10 Repeater Controller.

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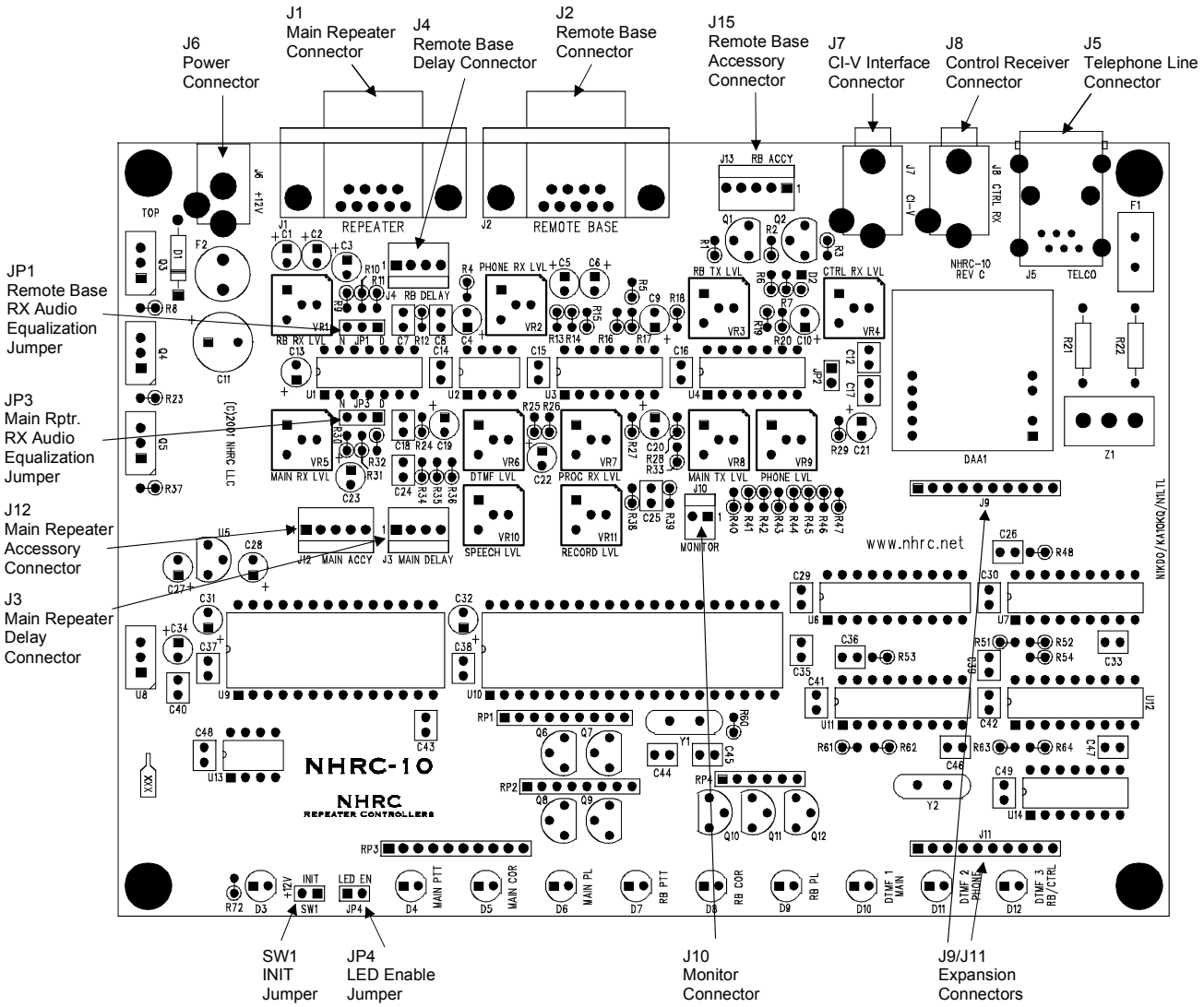

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9. Schematics

The following four pages are

1. The Revision “D” schematic for the NHRC-10 Repeater Controller.
2. The schematic for the IC-706 interface cable

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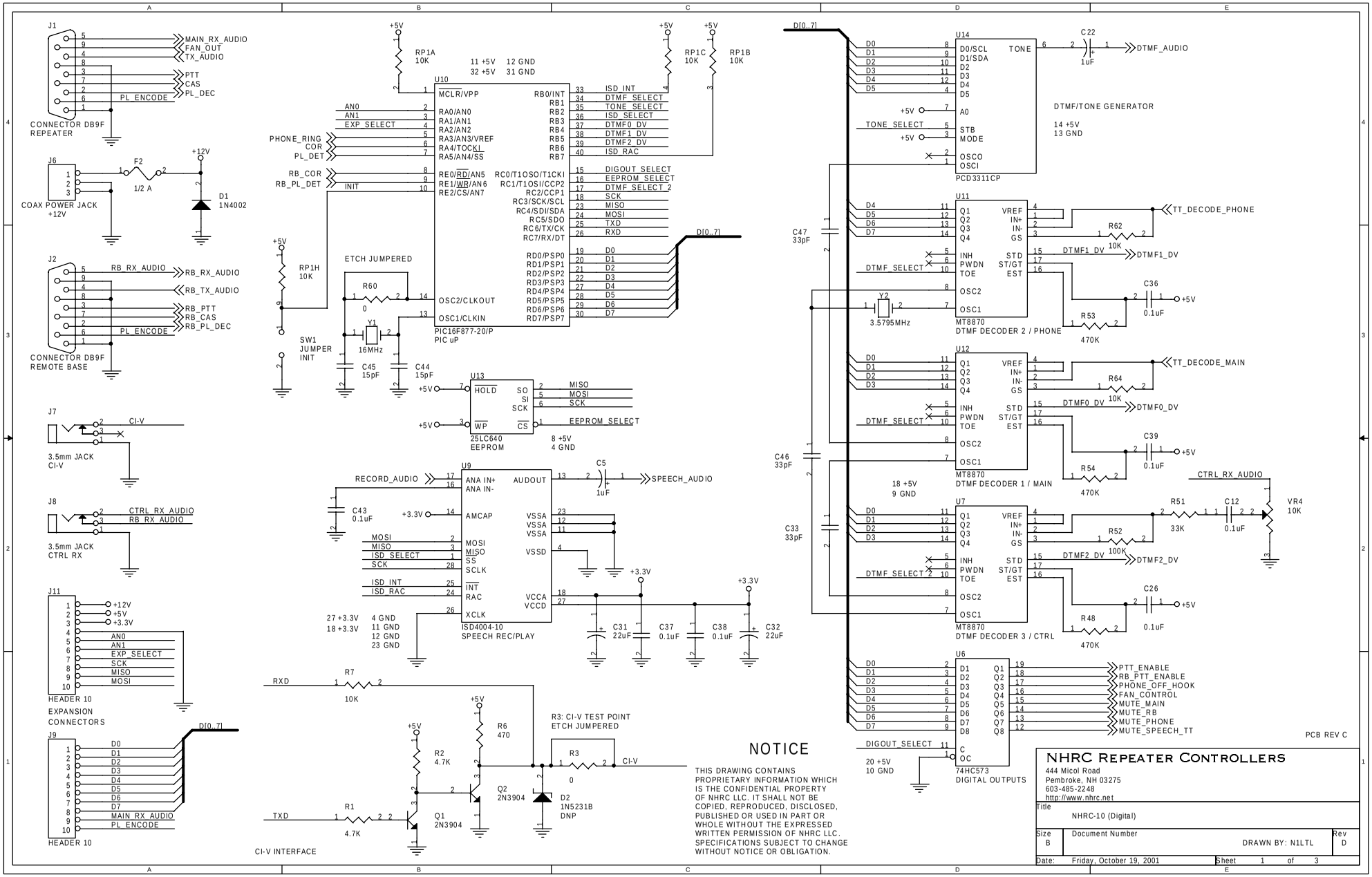
J1
MAIN_RX_AUDIO
FAN_OUT
TX_AUDIO
PTT
CAS
PL_DEC
PL_ENCODE
CONNECTOR DB9F
REPEATER
J6
F2
1/2 A
+12V
COAX POWER JACK
+12V
D1
1N4002
J2
RB_RX_AUDIO
RB_TX_AUDIO
RB_PTT
RB_CAS
RB_PL_DEC
PL_ENCODE
CONNECTOR DB9F
REMOTE BASE
J7
CI-V
3.5mm JACK
CI-V
J8
CTRL RX AUDIO
RB RX AUDIO
3.5mm JACK
CTRL RX
J11
+12V
+5V
+3.3V
AN0
AN1
EXP_SELECT
SCK
MISO
MOSI
HEADER 10
EXPANSION
CONNECTORS
J9
D0
D1
D2
D3
D4
D5
D6
D7
MAIN_RX_AUDIO
PL_ENCODE
HEADER 10
D[0..7]
RP1A
10K
11 +5V 12 GND
32 +5V 31 GND
U10
MCLR/VPP
RA0/AN0
RA1/AN1
RA2/AN2
RA3/AN3/VREF
RA4/TOCKI
RA5/AN4/SS
RE0/RD/AN5
RE1/WR/AN6
RE2/CS/AN7
OSC2/CLKOUT
OSC1/CLKIN
RB0/INT
RB1
RB2
RB3
RB4
RB5
RB6
RB7
RC0/T1OSO/T1CKI
RC1/T1OSI/CCP2
RC2/CCP1
RC3/SCK/SCL
RC4/SDI/SDA
RC5/SDO
RC6/TX/CK
RC7/RX/DT
RD0/PSP0
RD1/PSP1
RD2/PSP2
RD3/PSP3
RD4/PSP4
RD5/PSP5
RD6/PSP6
RD7/PSP7
ISD_INT
DTMF_SELECT
TONE_SELECT
ISD_SELECT
DTMF0_DV
DTMF1_DV
DTMF2_DV
ISD_RAC
DIGOUT_SELECT
EEPROM_SELECT
DTMF_SELECT_2
SCK
MISO
MOSI
TXD
RXD
PIC16F877-20/P
PIC uP
RP1C
10K
RP1B
10K
PHONE_RING
COR
PL_DET
RB_COR
RB_PL_DET
INIT
RP1H
10K
SW1
JUMPER
INIT
ETCH JUMPERED
R60
0
Y1
16MHz
C45
15pF
C44
15pF
U13
HOLD
WP
SO
SI
SCK
CS
25LC640
EEPROM
8 +5V
4 GND
EEPROM_SELECT
U9
ANA IN+
ANA IN-
AMCAP
MOSI
MISO
SS
SCLK
INT
RAC
XCLK
AUDOUT
VSSA
VSSD
VCCA
VCCD
ISD4004-10
SPEECH REC/PLAY
RECORD_AUDIO
SPEECH_AUDIO
C5
1uF
C43
0.1uF
27 +3.3V
18 +3.3V
4 GND
11 GND
12 GND
23 GND
C31
22uF
C37
0.1uF
C38
0.1uF
C32
22uF
R7
10K
R6
470
R2
4.7K
R1
4.7K
Q1
2N3904
Q2
2N3904
R3
0
R3: CI-V TEST POINT
ETCH JUMPERED
D2
1N5231B
DNP
CI-V
CI-V INTERFACE
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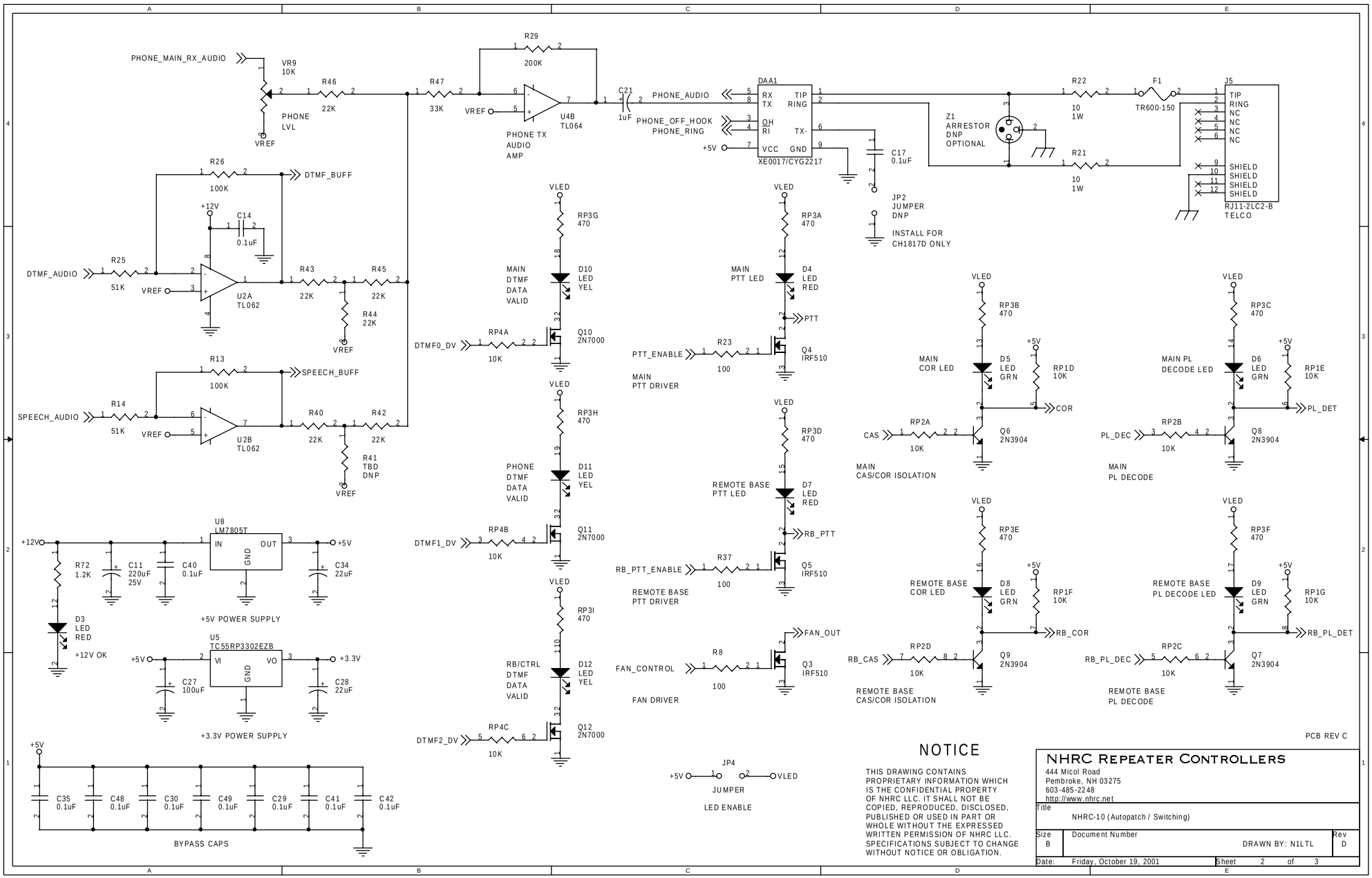
U14
D0/SCL
D1/SDA
TONE
A0
STB
MODE
OSCO
OSCI
PCD3311CP
DTMF/TONE GENERATOR
14 +5V
13 GND
C22
1uF
DTMF_AUDIO
U11
VREF
IN+
IN-
GS
INH
PWDN
TOE
STD
ST/GT
EST
OSC2
OSC1
MT8870
DTMF DECODER 2 / PHONE
R62
10K
TT_DECODE_PHONE
DTMF1_DV
C36
0.1uF
R53
470K
Y2
3.5795MHz
C47
33pF
U12
MT8870
DTMF DECODER 1 / MAIN
R64
10K
TT_DECODE_MAIN
DTMF0_DV
C39
0.1uF
R54
470K
C46
33pF
18 +5V
9 GND
U7
MT8870
DTMF DECODER 3 / CTRL
R52
100K
R51
33K
C12
0.1uF
VR4
10K
CTRL_RX_AUDIO
DTMF2_DV
C26
0.1uF
R48
470K
C33
33pF
U6
74HC573
DIGITAL OUTPUTS
20 +5V
10 GND
DIGOUT_SELECT
PTT_ENABLE
RB_PTT_ENABLE
PHONE_OFF_HOOK
FAN_CONTROL
MUTE_MAIN
MUTE_RB
MUTE_PHONE
MUTE_SPEECH_TT
PCB REV C
NHRC REPEATER CONTROLLERS
444 Micol Road
Pembroke, NH 03275
603-485-2248
http://www.nhrc.net
Title
NHRC-10 (Digital)
Size
B
Document Number
DRAWN BY: N1LTL
Rev
D
Date: Friday, October 19, 2001
Sheet 1 of 3



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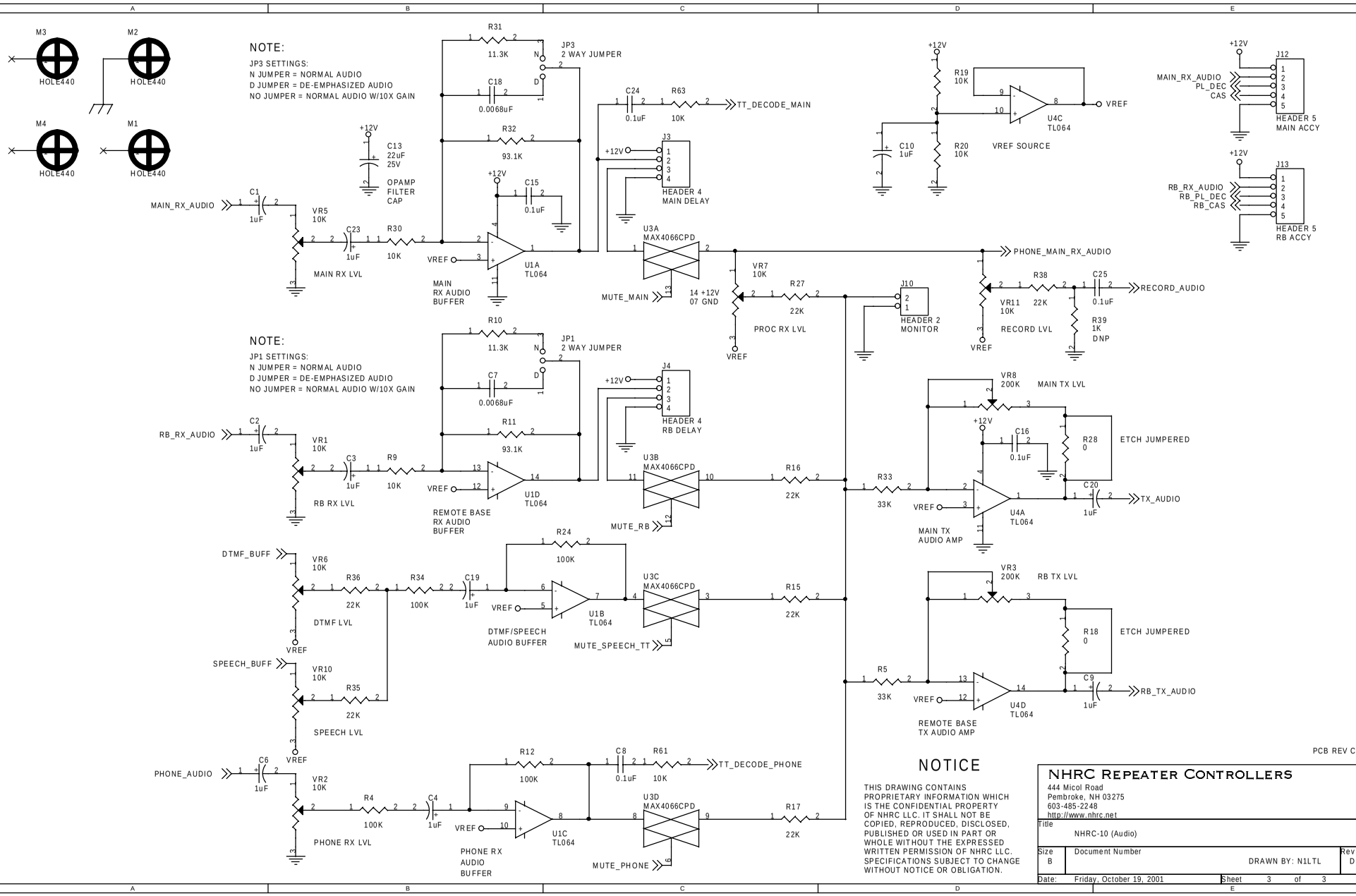
NHRC Repeater Controllers
444 Micol Road
Pembroke, NH 03275
603-485-2248
http://www.nhrc.net

Title: NHRC-10 (Autopatch / Switching)

Size	Document Number	Rev
B	DRAWN BY: N1LTL	D

Date: Friday, October 19, 2001 Sheet 2 of 3


M3
HOLE440
M2
HOLE440
M4
HOLE440
M1
HOLE440
NOTE:
JP3 SETTINGS:
N JUMPER = NORMAL AUDIO
D JUMPER = DE-EMPHASIZED AUDIO
NO JUMPER = NORMAL AUDIO W/10X GAIN
R31
11.3K
JP3
2 WAY JUMPER
C18
0.0068uF
R32
93.1K
C24
0.1uF
R63
10K
TT_DECODE_MAIN
+12V
C13
22uF
25V
OPAMP
FILTER
CAP
J3
HEADER 4
MAIN DELAY
MAIN_RX_AUDIO
C1
1uF
VR5
10K
MAIN RX LVL
C23
1uF
R30
10K
C15
0.1uF
VREF
U1A
TL064
MAIN
RX AUDIO
BUFFER
U3A
MAX4066CPD
MUTE_MAIN
14 +12V
07 GND
VR7
10K
R27
22K
PROC RX LVL
J10
HEADER 2
MONITOR
PHONE_MAIN_RX_AUDIO
R38
22K
C25
0.1uF
RECORD_AUDIO
VR11
10K
RECORD LVL
R39
1K
DNP
R19
10K
U4C
TL064
VREF
VREF SOURCE
C10
1uF
R20
10K
J12
HEADER 5
MAIN ACCY
MAIN_RX_AUDIO
PL_DEC
CAS
J13
HEADER 5
RB ACCY
RB_RX_AUDIO
RB_PL_DEC
RB_CAS
NOTE:
JP1 SETTINGS:
N JUMPER = NORMAL AUDIO
D JUMPER = DE-EMPHASIZED AUDIO
NO JUMPER = NORMAL AUDIO W/10X GAIN
R10
11.3K
JP1
2 WAY JUMPER
C7
0.0068uF
R11
93.1K
J4
HEADER 4
RB DELAY
RB_RX_AUDIO
C2
1uF
VR1
10K
RB RX LVL
C3
1uF
R9
10K
U1D
TL064
REMOTE BASE
RX AUDIO
BUFFER
U3B
MAX4066CPD
MUTE_RB
R16
22K
VR8
200K
MAIN TX LVL
C16
0.1uF
R28
0
ETCH JUMPERED
R33
33K
U4A
TL064
MAIN TX
AUDIO AMP
C20
1uF
TX_AUDIO
DTMF_BUFF
VR6
10K
DTMF LVL
R36
22K
R34
100K
C19
1uF
R24
100K
U1B
TL064
DTMF/SPEECH
AUDIO BUFFER
U3C
MAX4066CPD
MUTE_SPEECH_TT
R15
22K
VR3
200K
RB TX LVL
R18
0
ETCH JUMPERED
SPEECH_BUFF
VR10
10K
SPEECH LVL
R35
22K
R5
33K
U4D
TL064
REMOTE BASE
TX AUDIO AMP
C9
1uF
RB_TX_AUDIO
PHONE_AUDIO
C6
1uF
VR2
10K
PHONE RX LVL
R4
100K
C4
1uF
R12
100K
U1C
TL064
PHONE RX
AUDIO
BUFFER
C8
0.1uF
R61
10K
TT_DECODE_PHONE
U3D
MAX4066CPD
MUTE_PHONE
R17
22K
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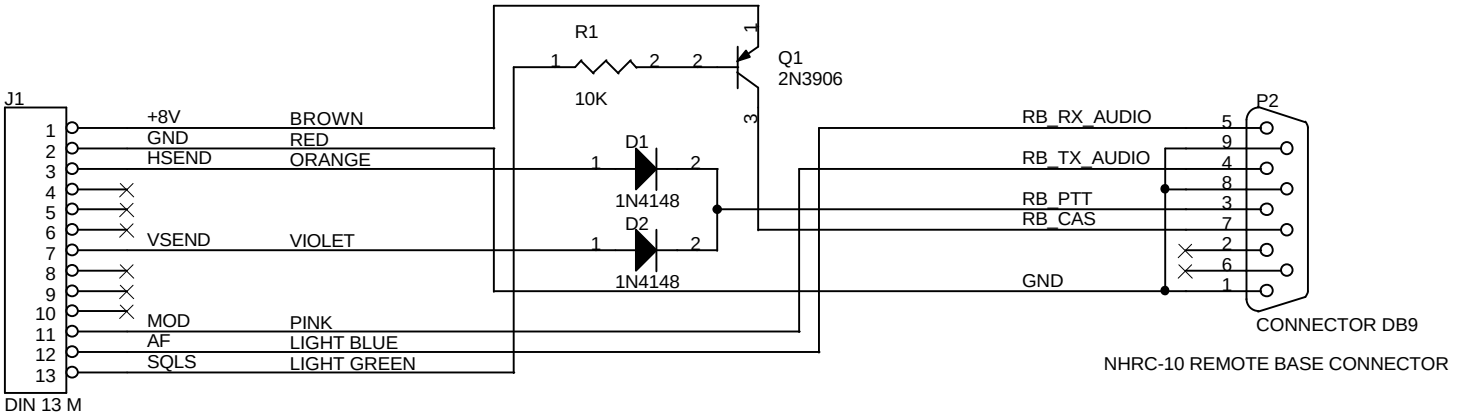
PCB REV C
NHRC Repeater Controllers
444 Micol Road
Pembroke, NH 03275
603-485-2248
http://www.nhrc.net
Title
NHRC-10 (Audio)
Size
B
Document Number
DRAWN BY: N1LTL
Rev
D
Date: Friday, October 19, 2001
Sheet 3 of 3



IC-706 ACC CONNECTOR

DIGIKEY P/N: CP-1013-ND
CUI STACK P/N: SD-130

NOTES:

1.) WIRE COLORS SHOWN ARE FROM ICOM SUPPLIED IC-706 ACCESSORY CONNECTOR PIGTAIL

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

Title: NHRC-10 to IC-706 Interface Cable

Size	Document Number	Rev
A		B

Date: Wednesday, June 14, 2000 Sheet 1 of 1

10. Parts List

The following is the bill of materials for revision "C" of the NHRC-10 Repeater Controller.

NHRC-10 Repeater Controller				**FOR REV C PCB ONLY**			NHRC Repeater Controllers
Bill of Materials							444 Micol Road
Revised: Thursday, November 22, 2001							Pembroke, NH 03275
Revision: D							http://www.nhrc.net
Item	Qty.	Ref.	Schematic Value	Description	Mfg.	Mfg. P/N	Notes
1	13	C1	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C2	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C3	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C4	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C5	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C6	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C9	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C10	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C19	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C20	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C21	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C22	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
		C23	1uF	1uF 16V Tantalum Cap	Panasonic	ECS-F1CE105K	
2	2	C18	0.0068uF	0.0068uF 50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA	
		C7	0.0068uF	0.0068uF 50V X7R Ceramic Radial Cap	Panasonic	ECU-S1H682KBA	
3	22	C8	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C12	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C14	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C15	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C16	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C17	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C24	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C25	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C26	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C29	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	

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		C30	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C35	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C36	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C37	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C38	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C39	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C40	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C41	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C42	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C43	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C48	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
		C49	0.1uF		0.1uF 50V Z5U Ceramic Radial Cap	Panasonic	ECU-S1H104MEA	
4	1	C11	220uF	25V	220uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM221	
6	1	C27	100uF	25V	100uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM101	
7	5	C13	22uF	25V	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
		C28	22uF	25V	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
		C31	22uF	25V	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
		C32	22uF	25V	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
		C34	22uF	25V	22uF 25V Aluminum Radial Electrolytic Cap	Panasonic	ECA-1EM220	
8	3	C33	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	
		C46	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	
		C47	33pF		33pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A330JCA	
9	2	C44	15pF		15pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A150JCA	
		C45	15pF		15pF 100V C0G Ceramic Radial Cap	Panasonic	ECU-S2A150JCA	
10	1	DAA1	XE0017/CYG2217		CyberGate DAA	CP Clare	CYG2217	
11	1	D1	1N4002		1A 100V Diode	Diodes Inc.	1N4002	
12	1	D2	1N5231B		5.1V 5% 500mW Zener Diode	Diodes Inc.	1N5231B	
13	3	D3	LED	RED	Red T1¾ Right Angle LED	Chicago	5300H1	
		D4	LED	RED	Red T1¾ Right Angle LED	Chicago	5300H1	
		D7	LED	RED	Red T1¾ Right Angle LED	Chicago	5300H1	
14	4	D5	LED	GRN	Green T1¾ Right Angle LED	Chicago	5300H5	
		D6	LED	GRN	Green T1¾ Right Angle LED	Chicago	5300H5	
		D8	LED	GRN	Green T1¾ Right Angle LED	Chicago	5300H5	
		D9	LED	GRN	Green T1¾ Right Angle LED	Chicago	5300H5	

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15	3	D10	LED	YEL	Yellow T1¾ Right Angle LED	Chicago	5300H7	
		D11	LED	YEL	Yellow T1¾ Right Angle LED	Chicago	5300H7	
		D12	LED	YEL	Yellow T1¾ Right Angle LED	Chicago	5300H7	
16	1	F1	TR600-150		PolySwitch Resettable Fuse 600V, 0.375A	Raychem	TR600-150	
17	1	F2	1A		PolySwitch Resettable Fuse 30V, 0.90A	Raychem	RUE090	
18	2	JP1	2 WAY JUMPER		3 Circuit Header, .100" Straight	Molex	22-03-2031	
		JP3	2 WAY JUMPER		3 Circuit Header, .100" Straight	Molex	22-03-2031	
19	1	JP2	JUMPER		2 Circuit Header, .100" Straight	Molex	22-03-2021	DO NOT POPULATE
20	2	JP4	JUMPER		2 Circuit Header, .100" Straight	Molex	22-03-2021	
		SW1	JUMPER		2 Circuit Header, .100" Straight	Molex	22-03-2021	
21	2	J2	CONNECTOR DB9F		DB9 Female PCB Right Angle Connector	AMP	787844-4	
		J1	CONNECTOR DB9F		DB9 Female PCB Right Angle Connector	AMP	787844-4	
22	2	J4	HEADER 4		4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041	
		J3	HEADER 4		4 Circuit Header, .100" Straight w/ lock	Molex	22-23-2041	
23	1	J5	RJ11-2LC2-B		6 Circuit Filtered RJ11 Jack, Shielded	Corcom	RJ11-2LC2-B	
24	1	J6	COAX POWER JACK		Coaxial Power Jack, Right Angle PCB mount	Switchcraft	RAPC712	
25	2	J7	3.5mm JACK		3.5mm 2 Circuit Right Angle Jack, PCB mt.	Cui-Stack	MJ-3536(N)	
		J8	3.5mm JACK		3.5mm 2 Circuit Right Angle Jack, PCB mt.	Cui-Stack	MJ-3536(N)	
26	2	J11	HEADER 10		10 Circuit Header, .100" Straight	Molex	22-03-2101	
		J9	HEADER 10		10 Circuit Header, .100" Straight	Molex	22-03-2101	
27	1	J10	HEADER 2		2 Circuit Header, .100" Straight w/ lock	Molex	22-23-2021	
28	2	J12	HEADER 5		5 Circuit Header, .100" Straight w/ lock	Molex	22-23-2051	
		J13	HEADER 5		5 Circuit Header, .100" Straight w/ lock	Molex	22-23-2051	
30	6	Q1	2N3904		NPN Transistor	Fairchild	2N3904	
		Q2	2N3904		NPN Transistor	Fairchild	2N3904	
		Q6	2N3904		NPN Transistor	Fairchild	2N3904	
		Q7	2N3904		NPN Transistor	Fairchild	2N3904	
		Q8	2N3904		NPN Transistor	Fairchild	2N3904	
		Q9	2N3904		NPN Transistor	Fairchild	2N3904	
31	3	Q3	IRF510		N Channel HEXFET	IRF	IRF510	
		Q4	IRF510		N Channel HEXFET	IRF	IRF510	
		Q5	IRF510		N Channel HEXFET	IRF	IRF510	
32	3	Q10	2N7000		N Channel MOSFET	Fairchild	2N7000	
		Q11	2N7000		N Channel MOSFET	Fairchild	2N7000	

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		Q12	2N7000	N Channel MOSFET	Fairchild	2N7000	
33	1	RP1	10K	10K x 8 Bussed Resistor Pack	Bourns	4609X-101-103	
34	1	RP2	10K	10K x 4 Isolated Resistor Pack	Bourns	4608X-102-103	
35	1	RP4	10K	10K x 3 Isolated Resistor Pack	Bourns	4606X-102-103	
36	9	R7	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R9	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R19	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R20	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R30	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R61	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R62	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R63	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
		R64	10K	10K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 10K	
37	1	RP3	470	470 x 9 Bussed Resistor Pack	Bourns	4610X-101-471	
38	1	R6	470	470 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470R	
39	2	R1	4.7K	4.7K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 4K7	
		R2	4.7K	4.7K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 4K7	
40	4	R3	0	Zero Ohm ¼W Jumper			ETCH JUMPERED
		R18	0	Zero Ohm ¼W Jumper			ETCH JUMPERED
		R28	0	Zero Ohm ¼W Jumper			ETCH JUMPERED
		R60	0	Zero Ohm ¼W Jumper			ETCH JUMPERED
41	7	R4	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R12	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R13	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R24	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R26	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R34	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
		R52	100K	100K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100K	
42	4	R5	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K	
		R33	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K	
		R47	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K	
		R51	33K	33K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 33K	
43	3	R8	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R	
		R23	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R	

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		R37	100	100 ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 100R	
44	2	R10	11.3K	11.3K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 11K3	
		R31	11.3K	11.3K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 11K3	
45	2	R32	93.1K	93.1K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 93K1	
		R11	93.1K	93.1K ¼W 1% Metal Film Resistor	Yaego	MFR-25FBF 93K1	
46	2	R14	51K	51K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 51K	
		R25	51K	51K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 51K	
47	13	R15	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R16	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R17	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R27	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R35	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R36	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R38	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R40	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R42	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R43	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R44	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R45	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
		R46	22K	22K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 22K	
48	2	R22	10 1W	10 1W 5% Metal Oxide Film Resistor	Panasonic	ERG-1SJ100	
		R21	10 1W	10 1W 5% Metal Oxide Film Resistor	Panasonic	ERG-1SJ100	
49	1	R29	200K	200K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 200K	
50	1	R39	1K	1K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 1K0	DO NOT POPULATE
51	1	R41	TBD				DO NOT POPULATE
52	3	R48	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K	
		R53	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K	
		R54	470K	470K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 470K	
53	1	R72	1.2K	1.2K ¼W 5% Carbon Film Resistor	Yaego	CFR-25JB 1K2	
54	2	U1	TL064	Quad JFET Input Op-Amp	TI	TL064CN	
		U4	TL064	Quad JFET Input Op-Amp	TI	TL064CN	
55	1	U2	TL062	Dual JFET Input Op-Amp	TI	TL062CP	
56	1	U3	MAX4066CPD	Quad SPST CMOS Analog Switch	Maxim	MAX4066CPD	
57	1	U5	TC55RP3302EZB	3.3V 250mA LDO Regulator	TelCom	TC55RP3302EZB	

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58	1	U6	74HC573		Octal D-Type Latch	TI	SN74HC573AN	
59	3	U7	MT8870		DTMF Decoder	Teltone	M-8870-01	
		U11	MT8870		DTMF Decoder	Teltone	M-8870-01	
		U12	MT8870		DTMF Decoder	Teltone	M-8870-01	
60	1	U8	LM7805T		5V 1.0A Voltage Regulator	Nat'l Semi	LM340T-5.0	
61	1	U9	ISD4004-10		10min. Single-Chip Voice Record/Playback	ISD	ISD4004-10MP	
62	1	U10	PIC16F877-20/P		8-Bit Microcontroller w/ A/D Converter	Microchip	PIC16F877-20/P	
63	1	U13	25LC640		64K (8Kx8) SPI Serial EEPROM	Microchip	25L640/P	
64	1	U14	PCD3311CP		DTMF/Musical Tone Generator	Philips	PCD3311CP	
65	9	VR1	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR2	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR4	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR5	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR6	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR7	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR9	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR10	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
		VR11	10K	POT	10K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B14	
66	2	VR8	200K	POT	200K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B25	
		VR3	200K	POT	200K 6mm Carbon Trimpot	Panasonic	EVN-D8AA03B25	
67	1	Y1	16MHz		16MHz Crystal	ECS	ECS-160-20-4	
68	1	Y2	3.5795MHz		3.579545MHz Crystal	ECS	ECS-35-17-4	
69	1	Z1	ARRESTOR		Balanced Three Chip SIDACtor	Teccor	P3203AB	DO NOT POPULATE
Addditional Components:								
70	2				DB9M Connector	NorComp	ET09P	mate for J1/J2
71	2				3.5mm 2 Conductor Male Plug	Cui-Stack	MP-3501	mate for J7/J8
72	1				Coaxial Power Plug, 2.5mm dia.	Switchcraft	760	mate for J6
73	2				4 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3047	mate for J3/J4
74	1				2 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3027	mate for J10
75	2				5 Circuit Housing, .100" w/ lock and polarizer	Molex	22-01-3057	mate for J12/J13
76	20				Crimp Terminal for Molex Housing	Molex	08-50-0114	
77	8				Shorting Jumpers	3M	929950-00-I	see note 2

Notes: 1. Arrestor Z1 is optional. DAA1 contains adaquate protection.

2. Shorting jumpers for use with J3, J4, JP1-5 and SW1 as required.

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11. NHRC LLC Limited Warranty

NHRC LLC warrants that it's assembled and tested products will be free from defects in materials and workmanship for a period of NINETY 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 it's kit products will contain components that are free from defects in materials and workmanship for a period of THIRTY 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 it's 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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