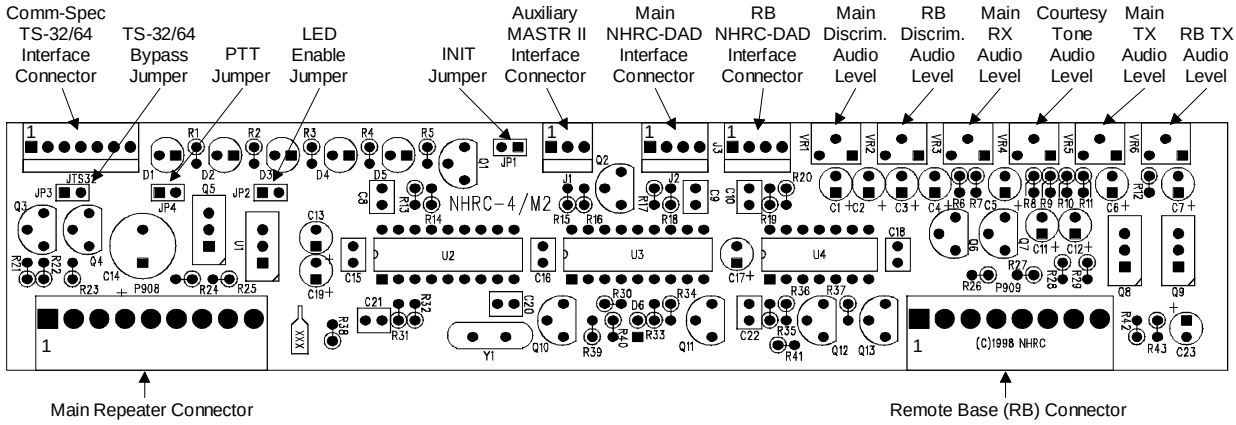
NHRC-4/M2 Repeater Controller

Installation Instructions

Rev. B Boards (shipped after January 1999)

These instructions will guide you in the installation and adjustment of the NHRC-4/M2 repeater controller.

Contents



Board Layout

1. MASTR II Preparation

The NHRC-4/M2 operates using the MASTR II as the "primary" radio. The primary radio must operate in full-duplex mode. If your MASTR II is not already converted for full-duplex operation, consult the NHRC WWW MASTR II info-site Full Duplex Conversion for duplexing information.

There are two options for interfacing the CAS and TX audio to the controller. These signals do not normally appear on the P908 plug on the system board of the MASTR II.

Option 1: Use an interface cable

Transmit audio and CAS appear on the controller at J1, a 3-pin header. Wire an interface cable as shown in the table below:

J1 Connections

J1 Pin #	MASTR II Signal
1	MIC HI J902 #6
2	CAS J904 #9
3	MIC LO J902 #5

Option 2: Modify the MASTR II System Board.

By cutting one trace and adding two wires to the MASTR II system board, the jumper described in option 1, above, can be avoided.

Add a wire that connects P908 pin 2 to J902 pin 6 (the exciter's MIC HI input). Cut the trace that leads to P908 pin 3 on the system board, and add a wire that connects P908 pin 3 to J904 pin 9 (the CAS signal from the IFAS board). Install 0 ohm resistors (jumpers) R22 and R38 on the NHRC-4/M2 board, enabling the CAS and TX audio signals on the J908 connector. Note that these jumpers may already be populated on your board. If you plan on using the local microphone on the MASTR II's control head, install a 1.5K resistor in location R38.

2. Secondary Radio Port Wiring

The controller provides the secondary radio port on the F3 through F8 frequency select leads, using the P909 connector. These leads are routed to the front panel control cable connector on the systems board. In mobile MASTR II radios, these control lines are sometimes subject to the installation of diodes and jumpers and cutting of traces to share channel elements across more than one channel selection. These diodes and jumpers must be removed, and the cut traces must be jumpered to for proper operation of the controller. Consult the MASTR II service manual for information on these jumpers.

Dissecting an old control cable makes an easy job of attaching your secondary radio to the MASTR II. In an E-chassis MASTR II, a bit of clever wiring in the systems board can allow a repeater on the "top deck" and the secondary, remote-base radio on the "bottom deck".

In base stations and repeaters, the P909 connector is unused. Individual wires must be attached to P909 to break out the secondary radio port.

P909 Secondary Radio Port Connections

P909 Pin #	NHRC-4/M2 Use	Frequency Select	J901 (control cable) Pin #
1	Secondary port CAS	F8	15
2	Secondary port PTT	F7	14
3	Secondary port CTCSS detect	F6	13
4	Secondary port receiver audio	F5	12
5	Secondary port transmitter audio	F4	11
6	Digital output	F3	10
7	no connection	F2	9
8	Unused, ground to select F1	F1	8

It is extremely important that the radio attached to the secondary radio port be provided with a common ground from the MASTR II. The "A-" lead (J901 pin 30) is a good spot. If this common ground is not provided, erratic operation or distorted audio

on the secondary radio will result. Also note that the Secondary port CAS requires an active **high** signal. Consult the NHRC-4/M2 Remote Base Breakout Application note for instructions on converting CAS from active low if an active high signal cannot be supplied.

3. TS-32/TS-64 hookup

Connector JTS32 is a 7-pin header that allows the easy installation of an optional Communications Specialists TS-32 or TS-64 for CTCSS decode, encode, CTCSS audio filtering, and reverse-burst. (Reverse burst is only available with the TS-64.) Wire JTS32 to the TS-32/TS-64 as follows:

JTS32 Connections

JTS32 Pin #	TS-32 Signal	Description
1	+V POWER	+10 volts to CTCSS board
2	CTCSS DECODER INPUT	receiver audio to CTCSS decoder
3	TO AUDIO FILTER INPUT	receiver audio to audio filter input (separate lead for TS-64)
4	FROM AUDIO FILTER OUTPUT	filtered audio to controller
5	CTCSS DETECT	decode signal from CTCSS decoder *See important warning below!*
6	CTCSS ENCODER OUTPUT	CTCSS tone to transmitter
7	- GROUND & HANG-UP	Ground

WARNING:

DO NOT APPLY VOLTAGE TO THE CTCSS DETECT INPUT!

This input is pulled low by the CTCSS decoder when CTCSS is NOT PRESENT.
It will float high when CTCSS is detected.
Application of voltage to this input will destroy Q4 and render the controller inoperative.
Damage of this nature is not covered by the NHRC Limited Warranty.

The TS-32 and the TS-64 both have a high-pass filter to remove the CTCSS tone from the repeated audio. By removing jumper JP3, the controller's audio can be passed through the audio filter on the TS-32/TS-64.

Note: If the audio filter is not used, then jumper JP3 must be installed in order for audio to be passed through the controller.

The Communications Specialists CTCSS boards are not supplied by NHRC. Contact Communications Specialists at 800-854-0547 directly to order these boards.

TS-64 Notes

Consult the NHRC-4/M2 TS-64 Application note for detailed connection instructions.

The TS-64 has a reverse-burst/PTT delay feature that can be used with the NHRC-4/M2. This feature is useful to eliminate the squelch crash received by the user's radio when the repeater transmitter drops. Note that the user's radios must have CTCSS decoding enabled for this to work. The NHRC-4/M2 provides support for the PTT delay through jumper JP4. JP4 pin 1 is the controller's PTT signal, and JP4 pin 2 is PTT to the MASTR II. If the reverse-burst/PTT delay feature is not used, then a jumper must be installed on JP4 so the controller can key the MASTR II.

Adjust the CTCSS deviation with R20 on the TS-64 board, with the "CG LEVEL" pot on the MASTR II exciter set to midrange. The ideal deviation for the CTCSS tone is 750 Hz.

Consult the TS-64 INSTRUCTION SHEET for details on setting the CTCSS frequency and the reverse burst.

TS-32 Notes

The TS-32 must have the JU-2 jumper cut. Use the OUT-2 signal from the TS-32 into the CTCSS detect of the NHRC-4/M2. If you want to be able to disable the CTCSS requirement, install a switch on the HANGUP lead. The TS-32 will supply CTCSS encode tone to the exciter through the NHRC-4/M2.

Adjust the CTCSS deviation with the R29 on the TS-32 board, with the "CG LEVEL" pot on the MASTR II exciter set to midrange. The ideal deviation for the CTCSS tone is 750 Hz.

Consult the TS-32 INSTRUCTION SHEET for details on setting the CTCSS frequency.

4. Installing the NHRC-4/M2 into the MASTR II

The controller installs in the MASTR II where the MASTR II "Channel Guard" board normally belongs, plugged into the top of the systems board in the front of the radio. If you have not already removed the Channel Guard board, do so now by pulling it straight up and out of the radio. The NHRC-4/M2 installs with the component side of the board facing the control head cable connector. Carefully line up the P908 (left side) and P909 (right side) connectors with the pins on the system board. Push the board down firmly until the connectors are right against the system board. The controller is now installed.

5. The LED Status Indicators

The NHRC-4 repeater controller is equipped with five status LEDS that aid in setup and troubleshooting. There are green LEDs for each radio port that indicate that the controller has getting a valid CAS (carrier operated switch) and, if a CTCSS decoder is connected, a a valid CTCSS decode signal. The appropriate green LED should light when its receiver is active, and, if a CTCSS decoder is present, the correct CTCSS tone is present. The yellow LED indicates that a DTMF signal is being decoded on the primary receiver. This LED should light for the entire duration that the DTMF signal is present on the primary receiver. The red LED's indicates transmit. These LED will light when its respective transmitter is transmitting.

The LEDS can be disabled to reduce the power consumption of the controller. Remove jumper JP2 to disable the LEDS.

6. Installing the NHRC-DAD with the NHRC-4/M2

J2 Primary Radio DAD
J3 Secondary Radio DAD

Pin	Use
1	+13.8 Volts to delay board
2	Audio **to** delay board
3	Audio **from** delay board
4	Ground/Audio Return

The audio delay for the primary radio simply plugs in to J2. The audio delay for the secondary radio plugs in to J3. If the audio delay is not installed, a jumper between pins 2 and 3 of the port's delay connector must be installed, or the controller will not pass audio.

It is strongly recommended that the CTCSS filter be used, as described above, if both CTCSS encode/decode and the audio delay are used.

See the Operation Instructions section on programming the flag bits to tell the controller the delay is present.

7. Using the Digital Output

The NHRC-4 Repeater Controller has a digital output that can be used for various remote control applications or to control a fan on the repeater's transmitter. The digital output is an open-drain into a power MOSFET, which is capable of sinking quite a bit of current, but we recommend a maximum load of about 500 mA. Use a relay to drive larger loads. The open-drain output can be used to gate the HOOKSWITCH signal to a TS-32 or other CTCSS decoder, to enable or disable CTCSS. Software allows the output to be enabled, disabled, or pulsed. In fan control mode, this output will be turned on when the transmitter is turned on, and turned off a programmable amount of time after the transmitter is turned off.

8. Adjusting the Audio Levels

Audio Level Adjustments

Potentiometer	Use
VR1	Primary Receiver Level
VR2	Secondary Receiver Mix Level
VR3	Primary Receiver Mix Level
VR4	Beep Tone Mix Level
VR5	Primary Transmitter Master Level
VR6	Secondary Transmitter Master Level

Preset all potentiometers to midrange. Key a radio on the primary input frequency, send some touch-tones, and adjust VR1 (the primary receiver level) until DTMF decoding is reliably indicated by yellow LED D5.

Note: If VR1 is set too high, a crackling noise may be heard in the transmitted audio during the hang time. Reduce the level set by VR1 until this noise goes away. Any repeated audio level reduction caused by adjusting VR1 can be compensated for by adjusting VR3 (primary receiver level) or VR5 (primary transmitter output level.)

The primary radio's transmit deviation is set with VR5 (the primary transmitter master level) on the controller board and the transmitter's deviation/modulation control. The key to properly adjusting these controls is to remember that the limiter in the transmitter is *after* VR5 but probably *before* the transmitter's deviation/modulation control. The transmitter's deviation/modulation control will set the actual *peak* deviation, and VR5 will set the level into the transmitter. You do not want excessive limiting on normal speech going through the repeater; it sounds bad and tends to "pump-up" background noise. On the other hand, some limiting is desirable. An oscilloscope connected to the audio output of a receiver tuned to the transmitter's frequency will show limiting as the audio gets "flat-topped" or clipped by the limiter. Ideally, a 4.5KHz deviation signal input to the repeater should result in a 4.5 KHz deviation output, and 5.5 KHz of input deviation should result in just under 5.0 KHz of deviation out of the repeater. A service monitor (or two), deviation meter, and/or a signal generator are necessary to do this job right.

The secondary radio's transmit deviation is set with VR2 (the secondary transmitter master level). Enable the secondary transmitter, and adjust VR2 for proper transmit deviation, similarly to VR5.

Enable the secondary receiver, and adjust VR6 for reasonable deviation on the enabled transmitters when a signal is received on the secondary receiver.

Adjust VR4 (the beep level) to set the courtesy tone and CW tone level.

VR3 is used to set the primary receiver's audio mix level, and may not need to be adjusted from midpoint.

NHRC-4/M2 Repeater Controller

Operation Guide

Software Version 1.4

These instructions will guide you in the operation of the NHRC-4/M2 Repeater Controller. For installation instructions, see the installation manual.

Contents

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1. Introduction

The NHRC-4/M2 has 2 radio "ports", which are connectors that the radios connect to. There is a "primary" and a "secondary" radio port.

The "primary" radio port is where the "main" repeater connects. All DTMF commands must come from here. When the primary radio is disabled, the secondary radio is also disabled.

The "secondary" radio port is where the secondary radio connects. The secondary radio can be a remote base, link radio, or a second repeater, which when activated, is "married" to the primary repeater. The secondary radio can be disabled without any effect on the primary radio. No DTMF commands are accepted from this port.

The secondary radio can be a "Remote Base," which is a simplex radio connected to the repeater system that allows the repeater users to remotely operate on a different frequency/mode/band than the repeater.

The secondary radio can be a link radio to interconnect the repeater on the main port to a distant repeater. The link radio can be simplex or full-duplex. In the case of a full-duplex link, the main receiver and the link receiver can be repeated over both transmitters simultaneously. A simplex link will always transmit when the main receiver is active, potentially blocking any traffic that might be received over the link at that time.

The secondary port can be connected to a repeater which will "marry" or "slave" to the main repeater. Anything received on either repeater will be re-transmitted by both

repeaters. This allows repeaters on two different bands to be easily and inexpensively linked.

The secondary port has several different modes of operation that apply to some or all of the applications described above. The secondary port's modes can only be selected by sending DTMF to the receiver connected to the primary radio port. These modes are:

- disabled
- alert mode
- monitor mode
- transmit mode

In disabled mode, the secondary radio port is ignored by the controller.

Alert Mode is a mode in which a different courtesy tone will be played if the receiver on the secondary port is unsquelched when the courtesy tone is requested. This is useful to indicate that traffic exists on a remote base frequency without having to hear the remote base traffic being repeated.

In monitor mode, the secondary radio's receiver audio is retransmitted over the primary repeater, but the secondary port is inhibited from transmitting. This mode is also useful for remote base operation and monitoring linked repeaters.

In transmit mode, the secondary radio's receiver audio is retransmitted by the primary radio, and the primary radio's audio is transmitted over the secondary radio. This mode is useful for remote bases, linked repeaters, and married repeaters.

A married repeater requires that the controllers "secondary port is a duplex repeater" option be set. This option changes how the PTT line to the secondary radio port operates. Normally, the secondary radio port's PTT line follows the primary radio port's CAS (receiver active) line, that is the secondary port transmits when enabled and the primary receiver is active. When the "secondary port is a duplex repeater" option is set, the secondary radio port's PTT line follows the primary radio port's PTT line, so that the courtesy tone and tail are transmitted on the married repeater.

The controller's programming is protected from unauthorized access by a 4-digit secret passcode. The controller is programmed by 8-digit DTMF commands that all begin with the 4-digit passcode. Throughout this manual, commands will be shown as *pppp*NNNN, where *pppp* represents the passcode, and NNNN is the actual command to the controller.

In order to save space in the microprocessor memory, the NHRC-4/M2 repeater controller represents all numbers in "hexadecimal" notation. Hexadecimal, or "hex" for short, is a base-16 number format that allows a 8-bit number to be represented in two

digits. Hex numbers are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. Converting decimal (the normal base-10 numbers that 10-fingered humans prefer) to hex is simple. Divide the decimal number by 16 to get the 1st hex digit (10=A, 11=B, 12=C, 13=D, 14=E, 15=F), the remainder is the 2nd hex digit. For example, 60 decimal = 3 x 16 + 12 = 3C hex. Any decimal number from 0 to 255 may be represented in only 2 hex digits.

Many scientific calculators can convert between these two number systems, and the Windows 95 calculator can, too, if the "scientific" view is selected. We provide a WWW page that can generate all the programming data for the NHRC-4/M2 controller quickly and easily, see *http://www.nhrc.net/nhrc4/nhrc4prog.html*.

A 16 key DTMF pad has keys 0-9 and A-D, which map directly to their corresponding hex digits. **Use the * key for digit E and the # key for digit F.** A 16-key DTMF pad is required to program the controller.

Note that all programming of the NHRC-4/M2 must be transmitted to the radio attached to the primary radio port.

2. Initializing the Controller

The controller will need to be initialized to allow you to set your secret passcode. Initializing the controller also resets all programmable settings to the factory defaults, including the CW ID message. It should not be nessecary to initialize the controller again, unless you want to change the passcode. **The only way to change the passcode is to initialize the controller.**

To initialize the controller, remove power and install the INIT jumper (JP1). Apply power to the controller, and after a few seconds, remove the INIT jumper. The controller is now in the initialize mode. If you "kerchunk" the primary port's receiver now, it will send the default CW ID of "DE NHRC/4". Now transmit (into the primary receiver) your 4-digit passcode. The controller will respond by sending "OK" in CW **once**. The controller will store the passcode and the main repeater will be enabled.

3. Programming the Controller

All programming is done by entering 8-digit DTMF sequences. The first 4 digits are the *passcode* chosen at initialization. The next 2 digits are an *address* or a *function code*. The last 2 digits are the *data* for address or function. To enter programming information, you must key your radio, enter the 8 digits, then unkey. If the controller understands your sequence, it will respond with "OK" in CW. If there is an error in your sequence, but the

passcode is good, the controller will respond with "NG". If the controller does not understand your command at all, it will not respond with anything other than a courtesy beep, and then only if the courtesy beep is enabled. If the controller is disabled, and an unrecognized command is entered, no response will be transmitted at all.

Responses to Commands

Response	Meaning
"OK"	Command accepted
"NG"	Command address or data is bad
Courtesy Beep or nothing	Command/password not accepted

If you enter an incorrect sequence, you can unkey before all 8 digits are entered, and the sequence will be ignored. If you enter incorrect address or data values, just re-program the location affected with the correct data.

1. ## Programming the Timers

   The NHRC-4/M2 Repeater Controller provides several timers which control the operation of your repeater. The *Hang Timer* controls how long the repeater will continue to transmit after a received signal drops. This is often called the repeater's "tail." The tail is useful to eliminate annoying squelch crashes on users' radios. As long as a reply is transmitted before the hang timer expires, the repeater will not drop, which would cause a squelch crash in the users' radios.

   The *Timeout Timer* controls the maximum duration of the retransmission of a received signal. It is more of a safety measure to protect the repeater from damage than a way to discourage long-winded users, even though it is often used that way. The NHRC-4/M2 has a separate timeout timer for each port. The timeout timer(s) can be disabled by programming a 0 length.

   The *ID Timer* sets the maximum duration between transmissions of the repeater's ID message(s). (Note that the NHRC-4/M2 may transmit an ID message before the timer expires in order to avoid transmitting the ID message while a user is transmitting.)

   The timer values are stored as an 8-bit value which allows a range of 0 to 255. Some of the timers require high-resolution timing of short durations, and others require lower resolution timing of longer durations. Therefore, timers values are scaled by either 1/10, 1, or 10 seconds, depending on the application.

Timer Address and Resolution

Timer	Address	Resolution Seconds	Max. Value Seconds
Hang Timer	03	1/10	25.5
Primary Receiver Timeout Timer	04	1	255
Secondary Receiver Timeout Timer	05	1	255
ID Timer	06	10	2550
Fan Timer	07	10	2550

Enter the 4-digit passcode, the timer address, and the timer value, scaled appropriately. For example, to program the Hang Timer for 10 seconds, enter **`ppppp0264`**, where *pppp* is your secret passcode, 02 is the hang timer address, and 64 is the hexadecimal value for 100, which would be 10.0 seconds.

2. Programming the CW Messages

CW messages are programmed by storing encoded CW characters into specific addresses in the controller. Use the Morse Code Character Encoding table and the Programming Memory Map to determine the data and address for the CW message characters. For example, to program "DE N1KDO/R" for the CW ID, you would use the following commands:

CW Message Programming Example

DTMF Command	Address	Data	Description/Purpose
*pppp*2609	26	09	D
*pppp*2702	27	02	E
*pppp*2800	28	00	space
*pppp*2905	29	05	N

*pppp*2A3*	2A	3E	1
*pppp*2B0D	2B	0D	K
*pppp*2C09	2C	09	D
*pppp*2D0#	2D	0F	O
*pppp*2*29	2E	29	/
*pppp*2#0A	2F	0A	R
*pppp*30##	30	FF	End of message marker

The CW ID can store a message of up to 20 characters. Do not exceed 20 characters. Be sure to include the end-of-message character (FF) at the end of each message.

3. Programming the Flag Bits

Controller features can be enabled with the use of the Configuration Flag Bits. These bits are encoded in a single byte, which is programmed into the controller at address 01. Multiple flag bits can be selected by adding their hex weights.

For example, to set up a controller with an audio delay on each port, and configure the digital output for fan control, you would add 02, 04, and 10 to produce hex 16, which you would then program into address 01 in the controller with this command: **`pppp0131`**

In addition to programming the flag bits as a group using address 01, the controller supports commands to set or clear these bits individually. Command 60 is used to clear (zero) a specified configuration bit, and command 61 is used to set (one) a specified configuration bit. For example, to set (turn on) bit 3 (to suppress DTMF muting), enter the following command: **`pppp6103`**. To clear bit 3 and enable the DTMF muting, enter this command: **`pppp6003`**. Note that the bit *number*, not it's hex weight is used for commands 60 and 61.

Configuration Flag Bits

Bit	Hex Weight	Binary Value	Feature
0	01	00000001	secondary port is duplex repeater
1	02	00000010	audio delay on primary receiver
2	04	00000100	audio delay on secondary receiver
3	08	00001000	disable DTMF muting
4	10	00010000	digital output is fan control
5	20	00100000	main receiver has priority over link receiver*
6	40	01000000	reserved
7	80	10000000	reserved

*** available in software version 1.4 and greater ONLY**

Example Configurations

Flag Bits Value	Features Selected
00	none
01	duplex repeater on secondary port
08	no DTMF muting
10	digital output is fan control
11	duplex repeater on secondary port digital output is fan control
17	duplex repeater on secondary port NHRC-DAD on primary port NHRC-DAD on secondary port digital output is fan control
36	NHRC-DAD on primary port NHRC-DAD on secondary port digital output is fan control main receiver has priority over link receiver*
1F	duplex repeater on secondary port NHRC-DAD on primary port NHRC-DAD on secondary port no DTMF muting digital output is fan control

*** available in software version 1.4 and greater ONLY**

4. Programming the Courtesy Tones

The NHRC-4/M2 uses up to five different courtesy tones to indicate various events:

- primary receiver
- primary receiver, the secondary transmitter enabled
- primary receiver, alert mode

- secondary receiver
- secondary receiver, secondary transmitter enabled

Each tone is individually programmable, and can be unique for that event, programmed to be the same as other events, or programmed empty to be silent.

The NHRC-4/M2 will play the appropriate courtesy tones 500 milliseconds (1/2 second) after a receiver drops. The courtesy tones all consist of four 100 millisecond (1/10 second) segments. Each segment can be no tone, low tone (a "boop", about 440 hertz), or high tone (a "beep", about 880 hertz). If all the segments are programmed as no tone, the courtesy tone will be disabled. The default courtesy tones are shown in the Default Courtesy Tones Table.

Default Courtesy Tones

Event	Default Tones	Binary Encoding	Hex Encoding
Primary Receiver	beep none none none	00 00 00 01	01
Primary Receiver Secondary Transmitter Enabled	beep none beep none	00 01 00 01	11
Primary Receiver Secondard Receiver Alert Mode	beep none boop none	00 11 00 01	31
Secondary Receiver	boop none none none	00 00 00 11	03
Secondary Receiver Secondary Transmitter Enabled	boop none boop none	00 11 00 11	33

The courtesy tones are encoded as four pairs of bits, with the first segment encoded as the two least significant bits, and the fourth segment encoded as the 2 most significant bits. Each pair of bits is allowed three possible values to indicate no tone, beep, or boop. The Half Courtesy Tones table shows tones generated for valid 4-bit values and their hex representation. To use this table, first determine the tones for each of the four segments, then find the hex digit that represents the first and second pair of tones. The second pair's digit becomes the first hex digit, and the first pair's digit becomes the second hex digit. For example, to encode a courtesy tone of boop-beep-boop-none, you would find the first pair (boop-beep)

in the table as the hex digit D and the second pair (boop-none) in the table as the hex digit 3, so your courtesy tone would be encoded as 3D.

Half Courtesy Tones

Tones	Binary Encoding	Hex Encoding
none none	00 00	0
none beep	01 00	4
none boop	11 00	C
beep none	00 01	1
beep beep	01 01	5
beep boop	01 11	7
boop none	00 11	3
boop beep	11 01	D
boop boop	11 11	F

5. Previewing Stored CW Messages

Stored CW messages can be previewed with the command *40* followed with the message number you want to preview. The message numbers can be found in the Message Numbers table. For example, to preview the secondary receiver timeout message, send command: **`pppp4004`**

4. Operating

1. Enabling/Disabling the Repeater

The radio ports can be disabled or enabled by remote control by setting the code for the operational mode in location 00. See the Operational Modes Table for the codes that indicate the mode you want.

Operational Modes

Code	Operational Mode
00	Primary & Secondary off
01	Primary enabled
02	Primary enabled, secondary alert mode
03	Primary enabled, secondary monitor mode
04	Primary enabled, secondary transmit mode

For instance, to disable the repeater, send command: **`pppp0000`**
To enable the repeater on the primary port, send command: **`pppp0001`**
To enable the repeater on the primary port, and select monitor mode for the secondary port, send command: **`pppp0003`**

2. Using the NHRC-DAD Digital Audio Delay with the NHRC-4/M2 Repeater Controller.

The NHRC-4/M2 Repeater Controller supports the optional NHRC-DAD digital audio delay board. The NHRC-DAD allows complete muting of received DTMF tones (no leading beep before muting), and suppression of squelch crashes when the received signal drops. The NHRC-DAD has a 128 ms delay on all received audio. The NHRC-4/M2 Repeater Controller supports an NHRC-DAD on both radio ports with a software switch and a dedicated DAD connector for each port. If the DAD is not present, then a jumper must be installed between pins 2 and 3 of the DAD connector (see installation manual). If the DAD is present, then the appropriate configuration flag bit must be set.

5. Programming Example

Programming the NHRC-4/M2 Repeater Controller can seem quite complicated at first. This section of the manual is intended as a tutorial to help you learn how to program your controller.

Let's assume we want to program a NHRC-4/M2 Repeater Controller with the following parameters:

CW ID: DE N1LTL/R FN42
Hang Time: 7.5 seconds
Timeout timer: 120 seconds

First, we will initialize the controller. Install INIT jumper JP1 and apply power to the controller to initialize. After a few seconds, remove JP1. Send DTMF **2381** to set access code to 2381. The controller will send "OK" in CW to indicate the passcode was accepted. Now the controller is initialized, and disabled.

Now we will enable the controller. Send DTMF **23810001** (passcode=2381, address=00, data=01). The controller will send "OK" in CW to indicate the command was successful.

We will now program the CW ID. Looking at the "Programming Memory Map", we can see that the first location for the CW ID is 26. The first letter of the ID is 'D', which we look up in the "Morse Code Character Encoding" table and discover that the encoding for 'D' is 09. Location 26 gets programmed with 09.

Send DTMF **23812609** to program the letter 'D' as the first character of the CW ID. The controller will send "OK" in CW if the command is accepted. If you entered the command correctly, but you don't get the "OK", your DTMF digits may not all be decoding. See the Installation Guide for your controller to readjust the audio level for the DTMF decoder.

The next character is the letter 'E', which is encoded as 02, and will be programmed into the next address, 27. Send DTMF **23812702**.

The next character is the space character, and it will be programmed into address 29. Send DTMF **23812800**. Here are the rest of the sequences to program the rest of the ID message:

23812905 (N in address 29)
23812A3* (1 in address 2A)
23812B12 (L in address 2B)
23812C03 (T in address 2C)
23812D12 (L in address 2D)
23812*29 (/ in address 2E)
23812#0A (R in address 2F)
23813000 (space in address 30)
23813114 (F in address 31)
23813205 (N in address 32)
23813330 (4 in address 33)
2381343C (2 in address 34)

After the last character of the CW ID is programmed, the End-of-Message character must be programmed. In this case, the last character of the ID message was programmed into address 34, so the EOM character, which is encoded as FF, goes into address 35: **238135##** (EOM into address 35.)

To program the hang timer, we must first determine the address of the hang timer by consulting the Programming Memory Map. The Hang Timer preset is stored in location 03. Next, we need to convert the 7.5 seconds into tenths, which would be 75 tenths of a second. Then the 75 gets converted to hex:

75 / 16 = 4 with a remainder of 11, so 75 decimal equals 4B hex.

Now program the hang timer preset by sending **2381034B**.

To program the primary receiver's timer with 120 seconds, we get the address of the primary receiver's timeout timer preset, which is 04, and then convert 120 seconds to hex:

120 / 16 = 7 with a remainder of 8, so 120 decimal equals 78 hex.

So we will program location 04 with 78: **23810478**

Any CW message can be played back at any time by "programming" location 40 with the message code you want to play. To play the CW ID, send **23814000**.

Tables

Message Contents

Message Number	Contents	Default
0	ID message	DE NHRC/4
1	primary receiver timeout message	TO
2	valid command confirm message	OK
3	invalid command message	NG
4	secondary receiver timeout message	RB TO

Programming Memory Map

Address	Default Data	Comment
00	01	enable flag 00 Primary & Secondary off 01 Primary repeater enabled 02 Primary enabled, secondary alert mode 03 Primary enabled, secondary monitor mode 04 Primary enabled, secondary transmit mode
01	10	Configuration Flags (see table)
02	00	Digital output control 00 off 01 on 02 1/2 sec on pulse
03	32	Hang timer preset, in tenths
04	1e	Primary receiver timout timer, in seconds
05	1e	Secondary receiver timout timer, in seconds
06	36	id timer preset, in 10 seconds
07	00	fan timer, in 10 seconds
08	01	primary receiver courtesy tone
09	11	primary receiver courtesy tone secondary transmitter enabled
0a	31	primary receiver courtesy tone secondary receiver alert mode
0b	03	secondary receiver courtesy tone
0c	33	secondary receiver courtesy tone secondary transmitter enabled
0d	00	reserved

0e	0f	'O' OK Message
0f	0d	'K'
10	ff	EOM
11	ff	EOM
12	ff	EOM
13	ff	EOM
14	05	'N' NG Message
15	0b	'G'
16	ff	EOM
17	ff	EOM
18	ff	EOM
19	ff	EOM
1a	03	'T' TO Message
1b	0f	'O'
1c	ff	EOM
1d	ff	EOM
1e	ff	EOM
1f	ff	EOM
20	0a	'R' TO Message
21	22	'B'
22	00	' '
23	03	'T'

24	0f	'O'
25	ff	EOM
26	09	'D' CW ID starts here
27	02	'E'
28	00	space
29	05	'N'
2a	10	'H'
2b	0a	'R'
2c	15	'C'
2d	29	'/'
2e	30	'4'
2f	0a	EOM
30	ff	EOM
31	ff	EOM
32	ff	EOM
33	ff	EOM
34	ff	EOM
35	ff	EOM
36	ff	EOM
37	ff	EOM
38	ff	EOM
39	ff	EOM

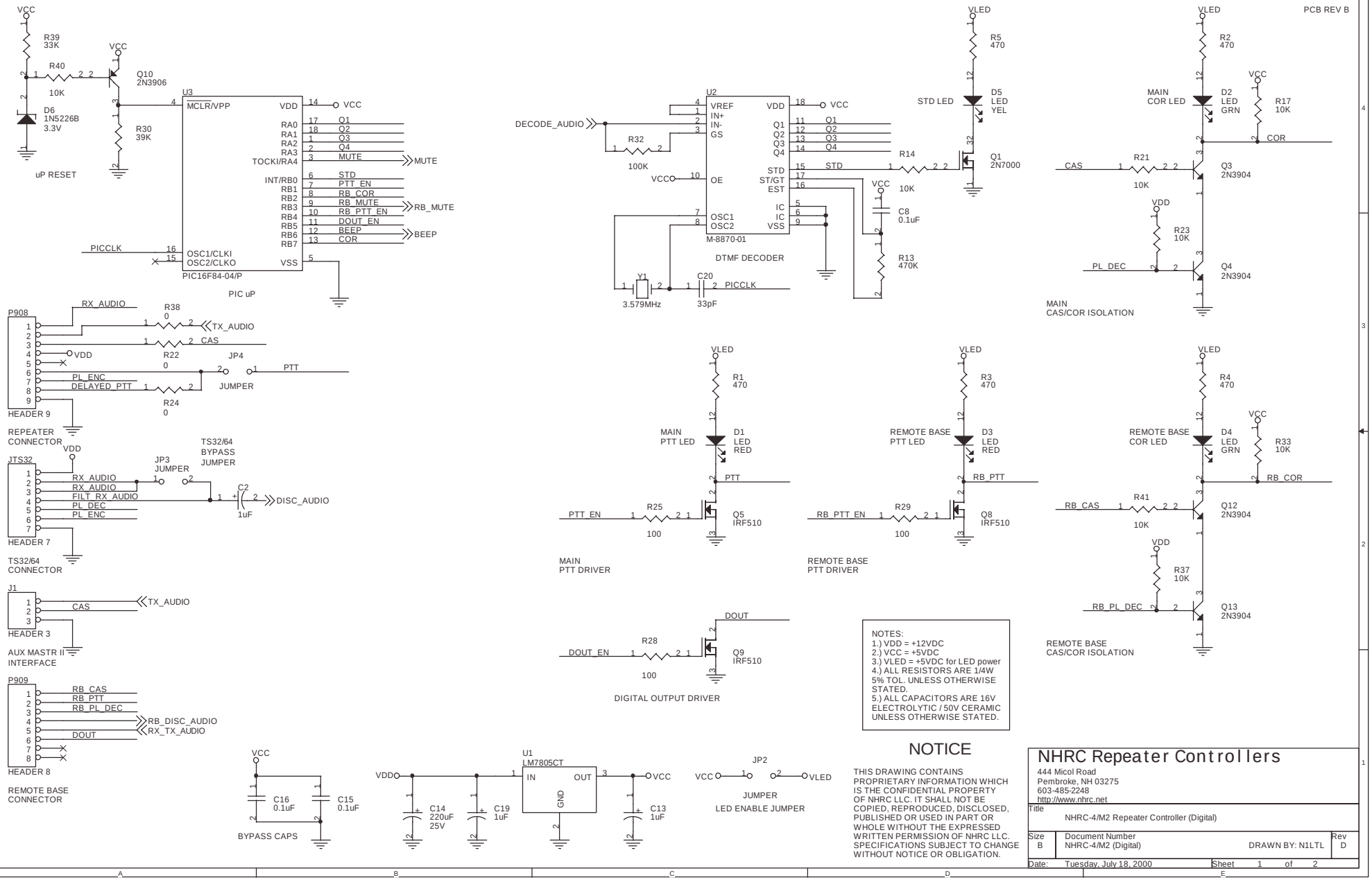
3a	ff	EOM can fit 20 letter id
3b	ff	EOM (safety)
3c	n/a	passcode digit 1
3d	n/a	passcode digit 2
3e	n/a	passcode digit 3
3f	n/a	passcode digit 4

Note that the entire range of 26-3B is available for your CW ID message.

Do not forget to terminate the message with the FF (end-of-message) character.

Morse Code Character Encoding

Character	Morse Code	Binary Encoding	Hex Encoding	Character	Morse Code	Binary Encoding	Hex Encoding
sk	. . . - . -	01101000	68	h	. . . .	00010000	10
ar	. - . - .	00101010	2a	i	. .	00000100	04
bt	- . . . -	00110001	31	j	. - - -	00011110	1e
/	- . . - .	00101001	29	k	- . -	00001101	0d
0	- - - - -	00111111	3f	l	. - . .	00010010	12
1	. - - - -	00111110	3e	m	- -	00000111	07
2	. . - - -	00111100	3c	n	- .	00000101	05
3	. . . - -	00111000	38	o	- - -	00001111	0f
4	. . . . -	00110000	30	p	. - - .	00010110	16
5	. . . . .	00100000	20	q	- - . -	00011011	1b
6	-	00100001	21	r	. - .	00001010	0a
7	- - . . .	00100011	23	s	. . .	00001000	08
8	- - - . .	00100111	27	t	-	00000011	03
9	- - - - .	00101111	2f	u	. . -	00001100	0c
a	. -	00000110	06	v	. . . -	00011000	18
b	- . . .	00010001	11	w	. - -	00001110	0e
c	- . - .	00010101	15	x	- . . -	00011001	19
d	- . .	00001001	09	y	- . - -	00011101	1d
e	.	00000010	02	z	- - . .	00010011	13
f	. . - .	00010100	14	space		00000000	00
g	- - .	00001011	0b	EOM		11111111	ff


PCB REV B
uP RESET
PIC uP
PIC16F84-04/P
DTMF DECODER
M-8870-01
MAIN CAS/COR ISOLATION
REPEATER CONNECTOR
HEADER 9
TS32/64 CONNECTOR
HEADER 7
AUX MASTR II INTERFACE
HEADER 3
REMOTE BASE CONNECTOR
HEADER 8
MAIN PTT DRIVER
REMOTE BASE PTT DRIVER
DIGITAL OUTPUT DRIVER
REMOTE BASE CAS/COR ISOLATION
BYPASS CAPS
JUMPER
LED ENABLE JUMPER
NOTES:
1.) VDD = +12VDC
2.) VCC = +5VDC
3.) VLED = +5VDC for LED power
4.) ALL RESISTORS ARE 1/4W 5% TOL. UNLESS OTHERWISE STATED.
5.) ALL CAPACITORS ARE 16V ELECTROLYTIC / 50V CERAMIC UNLESS OTHERWISE STATED.
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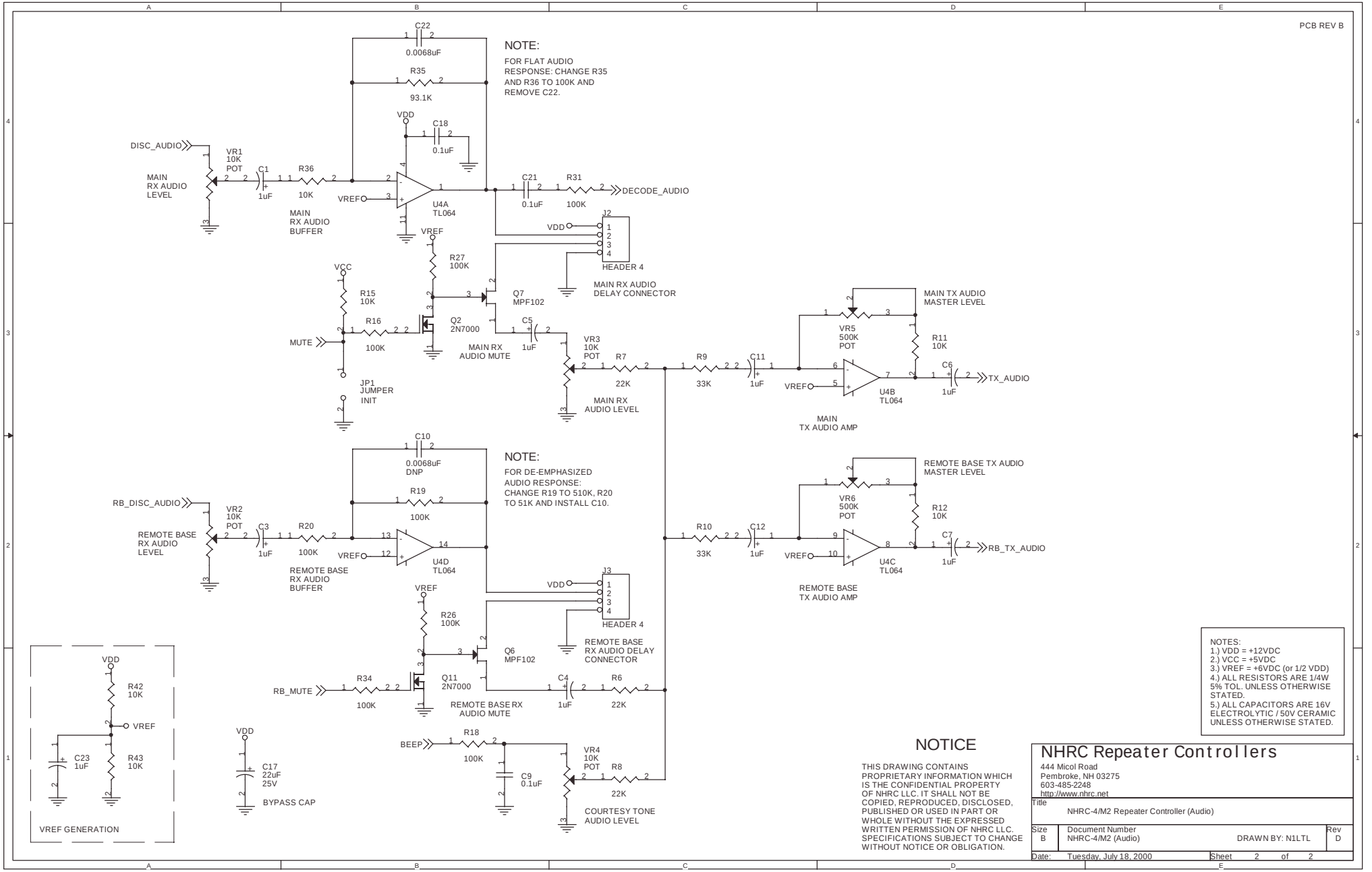
NHRC Repeater Controllers
444 Micol Road
Pembroke, NH 03275
603-485-2248
http://www.nhrc.net
Title
NHRC-4/M2 Repeater Controller (Digital)
Size B
Document Number NHRC-4/M2 (Digital)
DRAWN BY: N1LTL
Rev D
Date: Tuesday, July 18, 2000
Sheet 1 of 2



NOTICE

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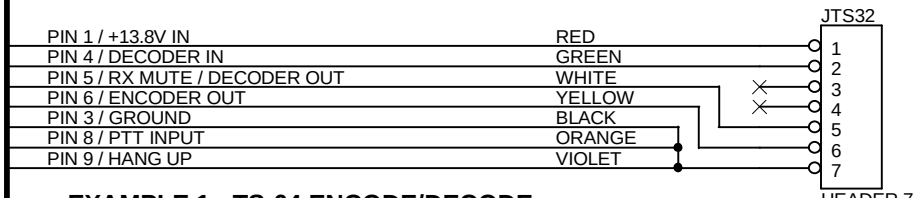
Title	NHRC-4/M2 Repeater Controller (Audio)	
Size B	Document Number NHRC-4/M2 (Audio)	Rev D
Date: Tuesday, July 18, 2000	DRAWN BY: N1LTL	Sheet 2 of 2

FOR NHRC-4/M2 (PCB REV B) CONTROLLERS ONLY.

COM-SPEC TS-64

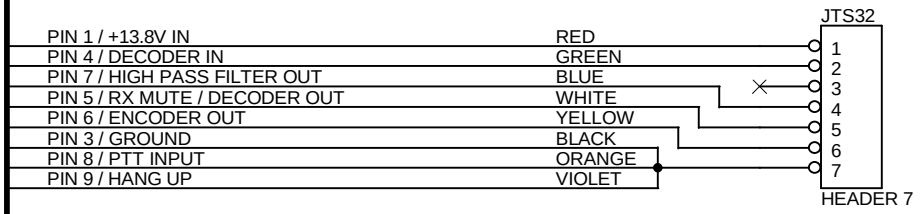
PLEASE CONSULT THE COM-SPEC DATA SHEET FOR FURTHER INFORMATION OR PRODUCTION CHANGES THAT MAY AFFECT THEIR PRODUCT. COM SPEC CAN BE REACHED AT 800-854-0547.



EXAMPLE 1: TS-64 ENCODE/DECODE WITHOUT PL FILTER OR REVERSE BURST

COM-SPEC TS-64

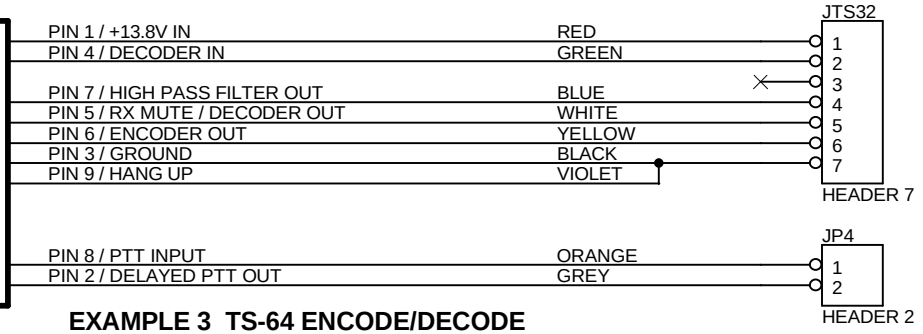
PLEASE CONSULT THE COM-SPEC DATA SHEET FOR FURTHER INFORMATION OR PRODUCTION CHANGES THAT MAY AFFECT THEIR PRODUCT. COM SPEC CAN BE REACHED AT 800-854-0547.



EXAMPLE 2: TS-64 ENCODE/DECODE WITH PL FILTER

COM-SPEC TS-64

PLEASE CONSULT THE COM-SPEC DATA SHEET FOR FURTHER INFORMATION OR PRODUCTION CHANGES THAT MAY AFFECT THEIR PRODUCT. COM SPEC CAN BE REACHED AT 800-854-0547.



EXAMPLE 3 TS-64 ENCODE/DECODE WITH PL FILTER AND REVERSE BURST PTT DELAY

NOTES:

1.) DO NOT JUMP J7 ON TS-64
2.) PIN 3 ON JTS32 IS UNUSED ON THE TS-64. IT IS USED FOR SUPPLYING DISC AUDIO TO THE OLDER TS-32 CTCSS BOARDS
3.) 2 PIN CONNECTOR MOLEX P/N 22-01-3027 (DIGI-KEY WM2011-ND) OR EQUIV.
7 PIN CONNECTOR MOLEX P/N 22-01-3077 (DIGI-KEY WM2016-ND) OR EQUIV.
CRIMP PIN INSERTS MOLEX P/N 08-50-0114 (DIGI-KEY WM2200-ND) OR EQUIV.
DIGI-KEY CAN BE REACHED AT (800-344-4539)
4.) PL FILTER SHOULD BE USED IN INSTALLTIONS WITH OPTIONAL DIGITAL AUDIO DELAY
5.) COM-SPEC TS-64 NOT SUPPLIED BY NHRC

NHRC Repeater Controllers
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Pembroke, NH 03275
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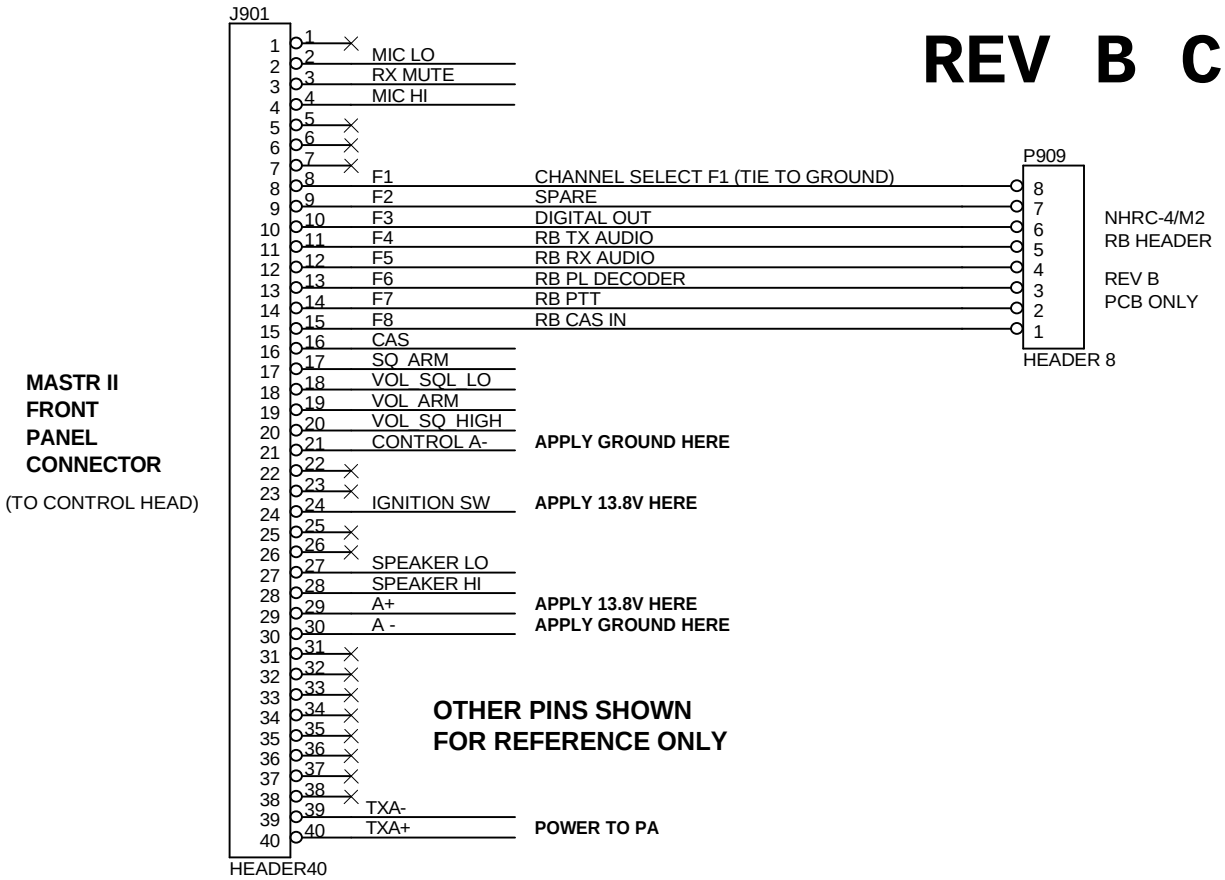
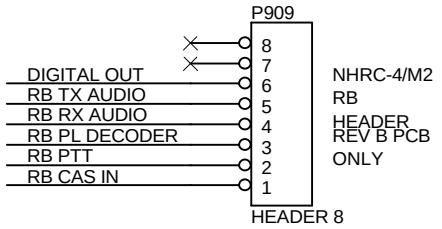
Title		
COM-SPEC TS-64 APP NOTE FOR NHRC-4/M2 REV B ONLY		
Size: A	Document Number: TS-64 APP NOTE	Rev: A
Date: Wednesday, November 18, 1998	Sheet 1 of 1	

REV B CONTROLLERS ONLY

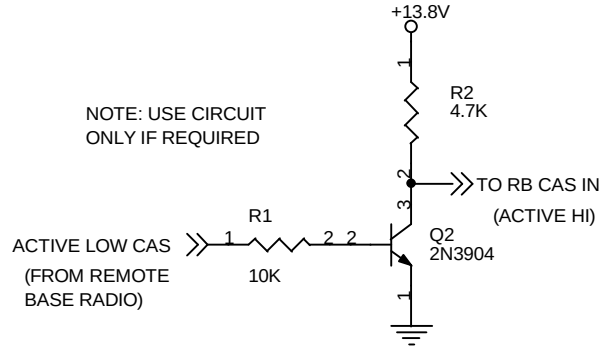


BASE STATION NOTES

P-909 IS UNUSED ON THE BASE STATION SYSTEMS BOARD. Individual wires will have to be added to break out the remote base from this board. Other mods may be necessary to enable repeat with the NHRC-4/M2. Please consult the GE MASTR II base station systems board diagram (GE P/N: LBI-4791) for further details.



CAS CONVERSION (Active LOW to Active HIGH)



NOTES:

The controller provides remote base on the frequency select leads F3 through F8. These leads are brought out to the front panel connector on the MASTR II mobile. In many MASTR II's, diodes, PCB cuts and/or jumpers may have been installed on these leads on the systems board for various reasons. It is important that any diodes and jumpers be removed. Consult the MASTR II service manual for further info on these modifications.

Please be sure to provide a common ground from the MASTR II to your remote base. The "A-" lead is a good spot. If a low impedance ground is not provided eratic PTT, COS operation and distorted remote base TX audio will result.

Also note that the RB CAS IN lead requires an active HIGH signal. See CAS Conversion circuit to show conversion from active low to active high signal if required.

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Title: NHRC4/M2 Remote Base Breakout Diagram		
Size: A	Document Number: NHRC-4/M2 (MASTR II Interconnect) FOR REV B CONTROLLERS	Rev: C
Date: Wednesday, December 15, 1999	Sheet 1 of 1	

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.