NHRC

REPEATER CONTROLLERS

NHRC-Remote +
Intelligent DTMF Remote Control
Programming and Operations Guide
Software Version 3.00, January 4, 2012

1   Introduction

The NHRC Remote + was designed to meet requests for a simple way to remotely control things around your shack or at your repeater site. Unlike other "dumb" remote controllers, the NHRC Remote + can provide Morse code telemetry in response to all valid commands. It is a very inexpensive but elegant way to implement control of any device or to help you comply with FCC rules by having a remote control channel for your repeater. The NHRC Remote + can be connected to any audio source, including a radio receiver or transceiver, without the need to modify the radio for any signals. All connections are similar to connecting a external speaker and microphone to your transceiver. In many cases, the NHRC-Remote + can be wired directly to a "data" or "accessory" jack on your radio. Consult your transceiver's operating manual for data or accessory connection instructions.

The NHRC Remote + allows you to control up to 8 loads by sending DTMF ("touch-tone") commands over any audio circuit. The heart of the NHRC Remote + is a Microchip PIC16F648A microcontroller and the Teltone M8870 DTMF decoder IC.

The NHRC Remote + will send command confirmation messages in Morse code. The confirmation can be sent over any audio circuit. This makes the device useful for radio or wireline applications. For radio applications, the NHRC Remote + can send a Morse code ID message a user defined amount of time after first transmitting.

2   Theory of operation

When audio arrives at the DTMF decoder, valid DTMF tones decoded by the M8870 cause the STD data valid signal to go high, at which point the microprocessor starts "listening" to the data from the DTMF decoder. Since it is only listening to the audio it does not know when you have stopped transmitting. The internal program starts a timer (the "inter-digit timer") that is restarted with each valid DTMF received from the DTMF decoder. All commands are evaluated and executed after the inter-digit timer expires. (The inter-digit timer is hard coded at 1.5 seconds) If DTMF tones have been detected, and there is a 1.5 second gap, the tones received up to the gap are evaluated and if a command code is matched, then the command is executed. This allows the NHRC-Remote+ to operate without a unsquelched signal from the receiver.

There are 16 unique command codes that control the outputs. Each port has its own "on" and "off" command. In addition to the 16 output control commands, there are four additional programming commands. All 20 of the commands can be re-programmed by the user. The user commands are stored in the microcontroller's internal EEPROM and are retained indefinitely. Each command can be up to 8 digits in length, and all 16 DTMF digits can be used (0-9, A, B, C, D, *, and #) allowing over 250,000,000 combinations.

The microcontroller processes the received digits, and if the digits match a command, sends the appropriate logic signals to the IRF510 power MOSFETs to control the loads. A high on the gate of the MOSFET causes the drain of the MOSFET to close to ground. (We chose open drain MOSFET outputs instead of relay outputs because relays can bounce making connection to digital circuitry a problem in some cases.) The NHRC Remote +'s outputs can drive well in excess of 1 amp allowing control of huge relays if required. Valid commands are acknowledged by asserting the PTT (push-to-talk) line (pulling it to ground) and sending a Morse code message of "ON", "OFF", "OK, or "ERR".

Status indicator LEDs show state of all channels, valid DTMF digit decode and the PTT line status. The status LEDs can be disabled for lower power consumption. The NHRC Remote+ draws about 14mA @13.8V with the LED's disabled making it ideal for solar powered applications.

3 Commands

There are 16 individual port on/off commands. Each turns one of the eight outputs on or off.

There are 4 programming commands: set configuration, load timers/data, program the Morse code ID message, and re-program commands.

All of the commands can be re-programmed by the user for increased security. See section 3.2.4 for instructions on re-programming the command codes.

In order to get you started easily, all commands have a "default" value set at the factory. The default values can be restored by using the "initialization" process, described in section 3.3.

Each command has a default value, and an "index", which is used to reference the particular command when you want to re-program it. Ignore the "index" value for now, it will be discussed later in the Programming Commands section.

3.1 Output Control

Output Control Commands

Index	Default	Usage
01	11	output 1 on
02	10	output 1 off
03	21	output 2 on
04	20	output 2 off
05	31	output 3 on
06	30	output 3 off
07	41	output 4 on
08	40	output 4 off
09	51	output 5 on
10	50	output 5 off
11	61	output 6 on
12	60	output 6 off
13	71	output 7 on
14	70	output 7 off
15	81	output 8 on
16	80	output 8 off

Assuming the default command values have not been changed, you can command port 1 on by sending "11", and command port 1 off by sending "10". You can command port 7 on by sending "71". As noted above, all of these commands can be re-programmed into ANY DTMF sequence, containing 1 to 8 of the DTMF codes 0-9, A-D, * and #.

3.2 Programming

Programming Commands

Index	Default	Usage
00	*0	Program Configuration Data
17	*1	Program Morse Code ID
18	*2	Program Timers / Direct Port Control
19	*3	Program Commands

3.2.1 Programming Configuration Switches

There are 24 on/off configuration switches that control the operation of the NHRC-Remote+. These are arranged into three groups of eight "switches". Seven of these switches are currently undefined and are reserved by NHRC for future expansion.

Each switch can be set to a off (0) or on (1) state. Each switch is addressed by its group number and switch number. The groups and switch numbers are all zero-based, that is to say the lowest numbered group is number zero and the lowest numbered switch is number zero. This makes the valid group numbers 0, 1, and 2, and the valid switch numbers 0 through 7.

3.2.1.1 Group 0 Switches – Remote + Configuration

Group 0 switches control configuration of the NHRC-Remote +. Note: In group 0, only switch 7 has a function. The other switches should not be changed from their default configuration of zero.

Group	Switch	Description	Default	Comment
0	0	reserved	0	
0	1	reserved	0	
0	2	reserved	0	
0	3	reserved	0	
0	4	reserved	0	
0	5	reserved	0	
0	6	reserved	0	
0	7	tone telemetry mode	0	1=send hi/lo tones instead of Morse code "ON" or "OFF"

Switch 7 is used to change the on/off telemetry the Remote+ sends from Morse code "ON" and "OFF" messages to two-tone sequences intended to notify the user of the state of the output. When this switch is turned on (1), a port on command will receive acknowledgement of a low tone followed by a high tone, and a port off command will receive acknowledgement of a high tone followed by a low tone.

Assuming the "program configuration command" has not been reprogrammed to something other than the factory default of "*0", sending the following command will enable the "tone telemetry mode":

```
*0071
```

3.2.1.2   Group 1 Switches – Port Pulsed Output Configuration

The group 1 switches are used to select pulsed operation for the each ports.

Group	Switch	Description	Default	Comment
1	0	digital output 1 pulse control	0	0=not pulsed, 1=pulsed
1	1	digital output 2 pulse control	0	0=not pulsed, 1=pulsed
1	2	digital output 3 pulse control	0	0=not pulsed, 1=pulsed
1	3	digital output 4 pulse control	0	0=not pulsed, 1=pulsed
1	4	digital output 5 pulse control	0	0=not pulsed, 1=pulsed
1	5	digital output 6 pulse control	0	0=not pulsed, 1=pulsed
1	6	digital output 7 pulse control	0	0=not pulsed, 1=pulsed
1	7	digital output 8 pulse control	0	0=not pulsed, 1=pulsed

When the indicated switch is set (1), the specified output will operate in pulsed mode. In pulsed mode, when the specified output is turned on, it will be turned off after the duration specified by the pulse timer. This allows devices to be "power-cycled", or push-button loads to be activated, for instance to open a garage door or to activate the "channel up" button on a radio.

Assuming the "program configuration command" has not been reprogrammed to something other than the factory default of "*0", sending the following command will set output 5 to pulsed operation:

```
*0141
```

Note that because the switch numbers are zero-based, to set output 5 to pulsed, you would set switch 4 to on (1).

Similarly, to return output 5 to on/off mode, send the following command:

```
*0140
```

3.2.1.3   Group 2 Switches – Direct Port Control

All port configuration data is stored in non-volatile EEPROM memory in the NHRC-Remote +. In addition to the output control commands described above, each port's on/off state can be set by using the Configuration Data directly.

Group	Item	Description	Default	Comment
2	0	digital output 1 control	0	
2	1	digital output 2 control	0	
2	2	digital output 3 control	0	
2	3	digital output 4 control	0	
2	4	digital output 5 control	0	
2	5	digital output 6 control	0	
2	6	digital output 7 control	0	
2	7	digital output 8 control	0	

Assuming the "program configuration command" has not been reprogrammed to something other than the factory default of "*0", sending the following command will set output 7 "on".

```
*0261
```

3.2.2 Programming the Morse Code ID

The NHRC-Remote + can send a Morse Code ID message to meet FCC requirements for transmitter identification.

The Morse Code ID can be programmed with up to 15 Morse Code symbols.

Use the table to find the codes for each symbol you want to program into the Morse Code ID message.

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

letter	code
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

3.2.2.1 Examples

All of these examples assume that the "Program the Morse Code ID" command has not been reprogrammed to something other than the factory default of "*1". If the "Program Morse Code ID" command has been re-programmed to something other than *1, replace *1 with the new command code in the examples shown below.

To program the Morse Code ID to "REMOTE PLUS", send the following DTMF tones:

```
*1 72 32 61 63 81 31 11 71 53 82 73
```

The spaces are shown for clarity, you do not need to send them.

To play the Morse Code ID, send the following DTMF tones:

```
*01
```

3.2.3 Program Timers/Direct Write to Output Latch

The NHRC-Remote+ has two programmable timers the user can program: the Morse Code ID timer, and the pulse duration timer.

A timer can be set from 0 to 255 units. Each timer has a "resolution" – this is the amount of time a timer unit takes.

The Morse Code ID timer has a resolution of 10 seconds, which allows it to be set from 10 to 2550 seconds.

The Pulse Timer has a resolution of .01 seconds, which allows it to be set from 0.1 to 2.55 seconds.

A timer is programmed by sending the "program timer" command, followed by the timer number, then the number of units to set.

3.2.3.1   Examples

All of these examples assume that the "Program Timers" command has not been reprogrammed to something other than the factory default of "*2". If the "Program Timers" command has been re-programmed to something other than *2, replace *2 with the new command code in the examples shown below.

Reprogram the Morse Code ID timer.

To program the Morse Code ID timer to 600 seconds – 10 minutes, send the following DTMF tones:

```
*2 0 60
```

The spaces are shown for clarity, you do not need to send them.

Simlarly, to program the pulse timer to 2.00 seconds, send the following command:

```
*2 1 200
```

It is also possible to directly write all eight outputs with a single command. This is useful for BCD channel selector logic, among other things. Note that the decimal value supplied is converted to 8-bit binary and that value is written directly to the output latch.

To turn on the lowest numbered 5 outputs, send the following command:

*2 2 31

(31 decimal = 00011111 binary)

3.2.4 Program Commands

All 20 of the commands the NHRC-Remote + accepts can be re-programmed by the user. Each command can consist of 1 to 8 DTMF digits, which include the numbers 0-9, the letters A-D, and the symbols * and #.

There is one extremely important caution the user must be aware of: the commands must be chosen carefully to avoid collisions. These collisions happen when the complete value of one command is exactly the same digits as the start of another command. For example:

User programs "123" for port 1 on command, and programs 1234 for port 2 on command. Then, when the user enters 1234, the NHRC-Remote+ will find command "123" before it finds command 1234, and port 1 will be turned on.

Another collision occurs if two commands are programmed to the same code. In this case, the first match the Remote+ finds will be used, and the other(s) ignored.

The table below lists all twenty programmable commands, along with the default values. Blank space is provided for you to record your programming settings for future reference.

Programming Worksheet

Index	Default	Usage	Your Value
00	*0	Program Configuration data	
01	11	output 1 on	
02	10	output 1 off	
03	21	output 2 on	
04	20	output 2 off	
05	31	output 3 on	
06	30	output 3 off	
07	41	output 4 on	
08	40	output 4 off	
09	51	output 5 on	
10	50	output 5 off	
11	61	output 6 on	
12	60	output 6 off	
13	71	output 7 on	
14	70	output 7 off	
15	81	output 8 on	
16	80	output 8 off	
17	*1	Program Morse Code ID	
18	*2	Program Timers / Direct Port Control	
19	*3	Program Commands	
99	N/A	Special Output Bulk Program	

Write your own programming codes into the table above.

To program a new command code, look up the index number for the command in the Programming Worksheet, shown above.

All of the commands are programmed as follows:

<Program-command-code><index><new-value>

where

program-command-code is the "Program commands" command, by default, "*3".
index is the index number for the command code, from the table shown above.
new-value is the new command keys to program for that function.

Examples

All of these examples assume that the "Program-Command" command has not been reprogrammed to something other than the factory default of "*3". If the "Program Command" command has been re-programmed to something other than *3, replace *3 with the new command code in the examples shown below.

To program the command for "output 6 on" (index #11) to be "369", send the following DTMF tones:

```
*3 11 369
```

To program the command for "output 2 on" (index #3) to be "992", send the following DTMF tones:

```
*3 03 992
```

3.2.4.1   Programming the "Program Commands" Cmmand

Special care is taken for re-programming the "program commands" command. In order to program thc "program commands" command, one must have physical access to the NHRC-Remote +. The controller checks for physical access by testing to see if the INIT jumper is installed when the new "program commands" command is entered.

Special care must be taken no not reset the controller when performing this operation.

Procedure:

1. Start with the NHRC-Remote + powered up.
2. Install the "JP1 INIT" jumper on the board.
3. Send the following DTMF tones:
   ```
   *3 19 <new-value>
   ```
   Replace <new-value> with the new "Program Commands" command.
4. Remove the "JP1 INIT" jumper.

Note that if you have already re-programmed the "Program Commands" command to something other than "*3", replace "*3" with your code in the examples.

DO NOT APPLY POWER TO THE CONTROLLER WITH THE INIT JUMPER ALREADY INSTALLED. If you do, you will initialize your NHRC-Remote+ to the as-shipped factory default programming. See Initialization.

3.2.4.2   Using the "Special Output Bulk Program" Feature

The NHRC-Remote+ supports a feature to program the output controls commands to share a common root code, followed by the port number and either "1" for on, or "0" for off. The root code is a sequence of 1 to 6 DTMF tones.

The Special Output Bulk Program" feature will program the on and off codes for all eight outputs at once. Each port is then controlled by sending the root code, port number, and either "0" for off or "1" for on.

Examples

All of these examples assume that the "Program-Command" command has not been reprogrammed to something other than the factory default of "*3". If the "Program Command" command has been re-programmed to something other than *3, replace *3 with the new command code in the examples shown below.

Sending the following DTMF Command will re-program all 16 (eight on and eight off) port commands to start with code "4321":

```
*3 99 4321
```

Resulting programming:

Command	Action
4311 1 0	port 1 off
4311 1 1	port 1 on
4311 2 0	port 2 off
4311 2 1	port 2 on
4311 3 0	port 3 off
4311 3 1	port 3 on
4311 4 0	port 4 off
4311 4 1	port 4 on
4311 5 0	port 5 off
4311 5 1	port 5 on
4311 6 0	port 6 off
4311 6 1	port 6 on
4311 7 0	port 7 off
4311 7 1	port 7 on
4311 8 0	port 8 off
4311 8 1	port 8 on

The "root code" can be from 1 to 6 digits in length. Beware of command collisions as described in Section 3.2.4

3.3 Initialization

The NHRC-Remote+ can be reset to the factory defaults by initialization. Note that all programming will be lost and the initial factory defaults will be loaded.

To initialize the NHRC-Remote+ to the as-shipped configuration, perform the following steps:

1.   Remove power.

2.   Install jumper JP1 "INIT".

3.   Apply power.

4.   Remove jumper JP1.

3.4 Electrical Adjustments

The NHRC-Remote+ has only two adjustments; VR1 and VR2.   VR1 sets the audio level of the CW output. Set this level to drive your transmitter to 4KHz deviation. VR2 controls the audio input level to the touch-tone decoder. Set this level for reliable touch-tone decode as noted by the DTMF decode LED D7.

3.5 Summary

The NHRC-emote+ is a simple and inexpensive way to keep things under control around your shack or repeater site. Its compact 3"x 3" size will allow it to be embedded inside your project or repeater. Its unique ability to respond to your commands eliminates the guesswork in remotely controlling your station. You won't be wondering "was my command received?" You will always know if the NHRC Remote + controller heard your command. The NHRC Remote + can be built in about an hour and you may already have some of the parts hanging around in your shack.

The NHRC-Remote+ is available assembled and tested or as a partial kit. Contact the factory or see our web site for current pricing. All prices are for domestic delivery, please inquire for international orders. The partial kit contains the printed circuit board (PCB is double sided with plated through holes, solder mask and silk screen), programmed microprocessor and DTMF decoder, a printed manual with a parts list for ordering all of the additional components from Digi-Key Corp. and detailed assembly instructions. The additional components needed to complete the kit cost about. $25 from Digi-Key Corp. Digi-Key can be reached at 1-800-344-4539. Technical support, answers to FAQ and ordering info is also available at our web site at **http://www.nhrc.net**

Orders can be sent to:

NHRC
415 Fourth Range Rd.
Pembroke, NH 03275.

Phone: 603-485-2248
Fax: 603-210-2248

http://www.nhrc.net

4 Electrical Connections

4.1 J1 Radio

J1 is a 5-position .100 header. This connector is used to interface the radio or other audio source to the NHRC-Remote+

J1 RADIO Electrical Connections

Pin	Use
1	No Connection
2	TX-Beep
3	Audio In
4	PTT Out (active low)
5	Ground

4.2 J2 Power

J1 is a 2-position .156 header. This connector is used to supply power to the NHRC-Remote+

J2 +12V Electrical Connections

Pin	Use
1	+12 (or 13.8) Volts
2	Ground

4.3 J3 Radio Interface

J1 is a 9-position .156 header. This connector is used to provide the open-drain outputs to loads. The output pin is pulled to ground when the output is enabled. These outputs can drive small relays directly, wire one side of the relay coil to +12 and the other side to the NHRC-Remote+.

J2 REPEATER Electrical Connections

Pin	Use
1	Output 8
2	Output 7
3	Output 6
4	Output 5
5	Output 4
6	Output 3
7	Output 2
8	Output 1
9	+12

5 Assembly of the NHRC-Remote+

The NHRC-Remote+ is a fairly simple project to build. Minimal electronic experience is required. Assembly time should be around 1 hour.

Organize your parts per the parts list. Use a small soldering iron of approximately 25 watts. (DO NOT USE A SOLDERING GUN). Consider using a water-soluble flux-core solder (such as Alpha Metals Aqualine 6000). Rinsing well under hot tap water will remove the flux and your finished project will look professional. Rosin flux-core solder is OK as well, but be sure to clean your board after assembly with isopropyl alcohol.

As you install a part check it off on your parts list. *Socket your chips!* Pin 1 of many components are denoted by the square pad on the PCB. Install the IRF510 FETs (Q1-8) so the heatsink surface faces J3, note the silkscreen orientation of the LEDs (D1-8) and small transistors (Q9-10) when installing them. Be careful to install all polarized capacitors (C2, C6, and C7) per the silkscreen (note the "+" sign). Reversing the polarity of the caps will let the smoke out of them.

Once assembly is complete, power up your board without the chips installed. Refer to the schematic and check voltages to your chips. (Example: +5 volts across bypass caps C1 and C4) When all checks out OK, install the chips in their sockets, power-up the board, INIT the processor and enjoy!

Notes:

A detailed troubleshooting guide is available on our web site at **http://www.nhrc.net.**

Alpha Metals solder info is available at **http://www.alphametals.com**
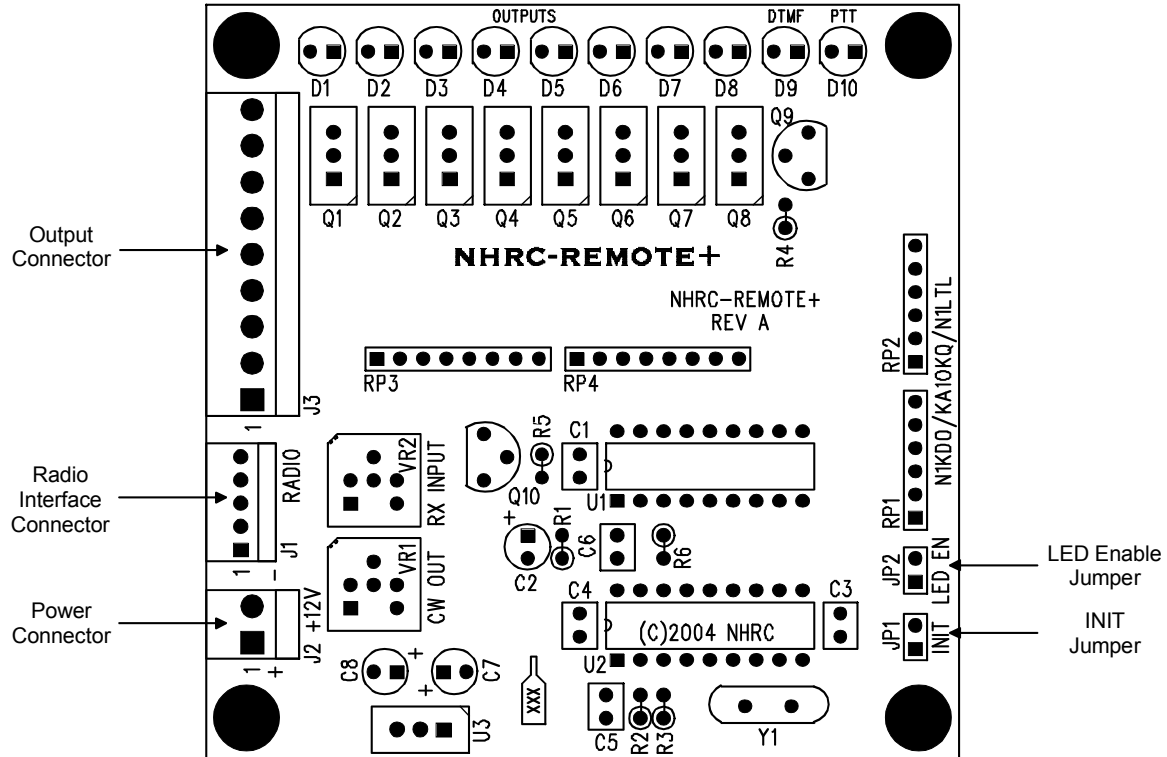
SOCKET YOUR CHIPS

Assembly notes for PCB Rev A:

1. Socket your chips

2. Square pad denotes pin 1 for ICs, + lead of capacitors, and Anode of LEDs.

3. U3 (7805) heat sink faces out

4. DO NOT USE A SOLDERING GUN. Use only a 25-watt or temperature controlled soldering iron.

5. Use Rosin Core solder or Alpha Metals Aqualine 6000. If you use the Aqualine solder, be sure to wash all the flux off the board with hot water.

Technical support is available on our web site at http://www.nhrc.net

NHRC LLC Limited Warranty

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

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

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

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

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

Some states or countries do not allow the limitation of incidental or consequential damages, so the paragraph above may not apply to you.
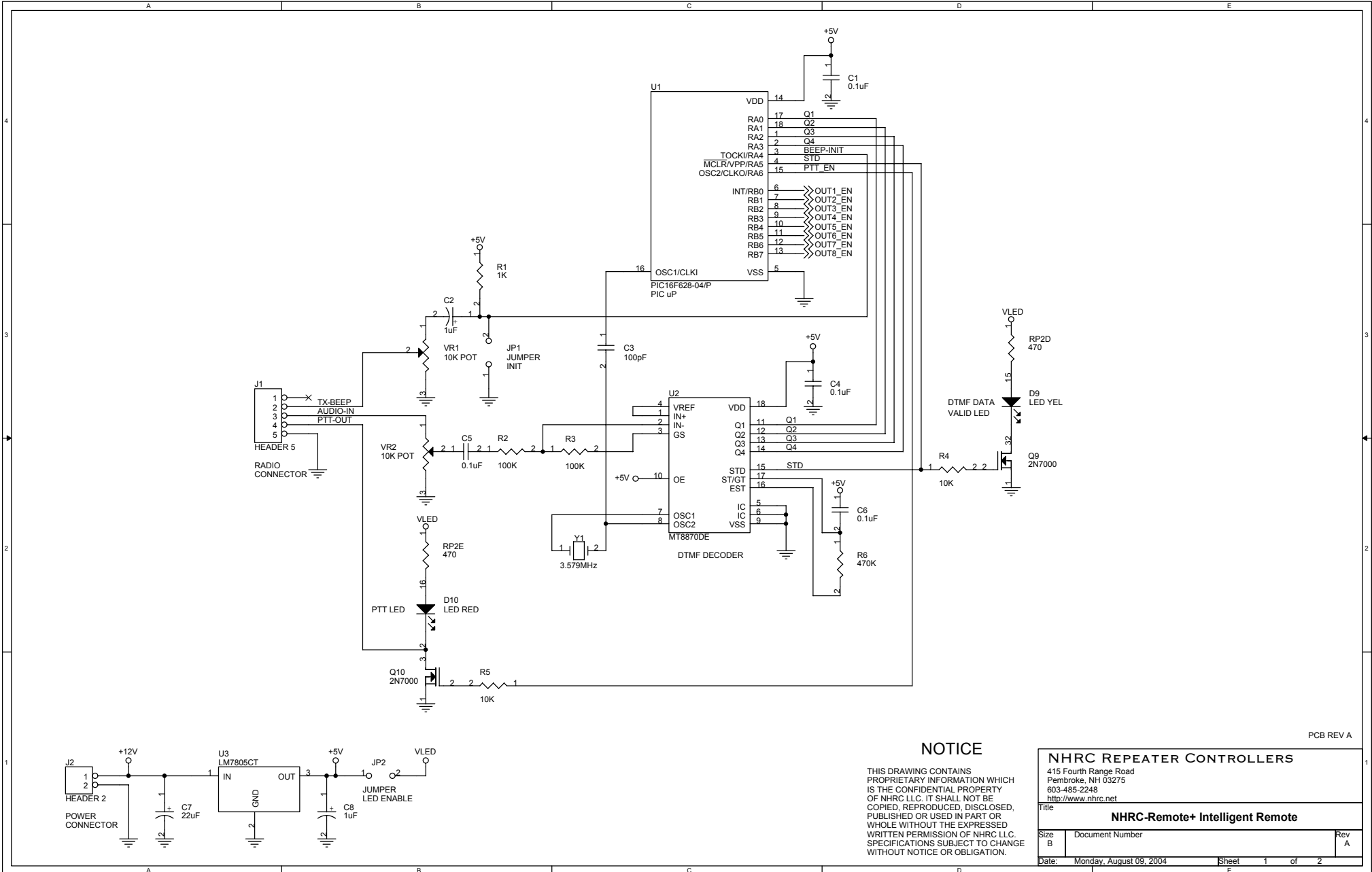
This warranty applies only to the original purchaser of the product; proof of purchase must be presented to receive warranty service.

NHRC Repeater Controllers

NHRC-Remote+ Intelligent Remote Controller
Bill Of Materials
PCB rev A

Item	Qty	Reference	Part	Description	Populate	Manufacturer	Manufacturer P/N	Digi-Key P/N	Notes
1	4	C1,C4,C5,C6	0.1uF	0.1uF 50V Z5U Ceramic Radial Cap	YES	Panasonic	ECU-S1H104MEA	P4924-ND	
2	2	C2,C8	1uF	1uF 16V Tantalum Cap	YES	Panasonic	ECS-F1CE105K	P2105-ND	
3	1	C3	100pF	100pF 100V C0G Ceramic Radial Cap	YES	Panasonic	ECU-S2A101JCA	P4849-ND	
4	1	C7	22uF	22uF 25V Aluminum Radial Electrolytic Cap	YES	Panasonic	ECA-1EM220	P5149-ND	
5	8	D1,D2,D3,D4,D5,D6,D7,D8	LED GRN	Green T1¾ LED	YES	Lite-On	LTL-4233	160-1130-ND	
6	1	D9	LED YEL	Yellow T1¾ LED	YES	Lite-On	LTL-4253	160-1133-ND	
7	1	D10	LED RED	Red T1¾ LED	YES	Lite-On	LTL-4223	160-1127-ND	
8	2	JP1,JP2	JUMPER	2 Circuit Header, .100" Straight	YES	Molex	22-03-2021	WM4000-ND	
9	1	J1	HEADER 5	5 Circuit Header, .100" Straight w/ lock	YES	Molex	22-23-2051	WM4203-ND	
10	1	J2	HEADER 2	2 Circuit Header, .156" Straight w/ lock	YES	Molex	26-60-4020	WM4620-ND	
11	1	J3	HEADER 9	9 Circuit Header, .156" Straight w/ lock	YES	Molex	26-60-4090	WM4627-ND	
12	8	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8	IRF510	N Channel HEXFET 100V 5.6A	YES	International Rectifier	IRF510	IRF510-ND	
13	2	Q9,Q10	2N7000	N Channel MOSFET 60V 200mA	YES	Fairchild	2N7000	2N7000FS-ND	
14	2	RP2,RP1	470	470 X 5 Bussed SIP Resistor Pack	YES	Bourns	4606X-101-471	4606X-1-471-ND	
15	2	RP3,RP4	100	100 X 4 Isolated SIP Resistor Pack	YES	Bourns	4608X-102-101	4608X-2-101-ND	
16	1	R1	1K	1K ¼W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-1K0	1.0KQBK-ND	
17	2	R2,R3	100K	100K ¼W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-100K	100KQBK-ND	
18	2	R4,R5	10K	10K ¼W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-10K	10KQBK-ND	
19	1	R6	470K	470K ¼W 5% Carbon Film Resistor	YES	Yageo	CFR-25JB-470K	470KQBK-ND	
20	1	U1	PIC16F628-04/P	PIC Microcontroller (Blank)	YES	Microchip	PIC16F628-04/P	PIC16F628-04/P-ND	*
21	1	U2	MT8870DE	DTMF Decoder	YES	Zarlink	MT8870DE		*
22	1	U3	LM7805CT	5V 1.0A Voltage Regulator	YES	Fairchild	LM7805CT	LM7805CT-ND	
23	2	VR1,VR2	10K POT	10K 6mm Carbon Trimpot	YES	Panasonic	EVN-D8AA03B14	D4AA14-ND	
24	1	Y1	3.579MHz	3.579545MHz Crystal	YES	ECS	ECS-35-17-4	X079-ND	
Additional Items									
25	1			NHRC-REMOTE+ PCB rev A		NHRC	NHRC-REMOTE+ PCB rev A		*
26	2			18 Pin DIP Socket		Assmann	A18-LC-TT	AE8918-ND	
27	1			9 Circuit Housing, .156" w/ lock and polarizer		Molex	09-50-8093	WM2118-ND	
28	2			2 Circuit Housing, .156" w/ lock and polarizer		Molex	09-50-8023	WM2111-ND	
29	2			5 Circuit Housing, .100" w/ lock and polarizer		Molex	22-01-3057	WM2003-ND	
30	11			Crimp Terminal for Molex .156" Housing		Molex	08-50-0106	WM2300-ND	
31	5			Crimp Terminal for Molex .100" Housing		Molex	08-50-0114	WM2200-ND	
32	2			Shorting Jumpers		3M	929950-00-I	929950-00-ND	

Notes

* U1 (Programmed), U2 and PCB are included w/ the NHRC-REMOTE+ kit.

+5V

C1
0.1uF

U1

VDD 14

RA0 17 Q1
RA1 18 Q2
RA2 1 Q3
RA3 2 Q4
TOCKI/RA4 3 BEEP-INIT
MCLR/VPP/RA5 4 STD
OSC2/CLKO/RA6 15 PTT_EN

INT/RB0 6 OUT1_EN
RB1 7 OUT2_EN
RB2 8 OUT3_EN
RB3 9 OUT4_EN
RB4 10 OUT5_EN
RB5 11 OUT6_EN
RB6 12 OUT7_EN
RB7 13 OUT8_EN

OSC1/CLKI 16
VSS 5

PIC16F628-04/P
PIC uP

+5V

R1
1K

C2
1uF

VR1
10K POT

JP1
JUMPER
INIT

C3
100pF

+5V

C4
0.1uF

U2

VREF 4
IN+ 1
IN- 2
GS 3

VDD 18

Q1 11 Q1
Q2 12 Q2
Q3 13 Q3
Q4 14 Q4

STD 15 STD
ST/GT 17
EST 16

OE 10 +5V

OSC1 7
OSC2 8

IC 5
IC 6
VSS 9

MT8870DE

DTMF DECODER

VLED

RP2D
470

D9
LED YEL

DTMF DATA
VALID LED

Q9
2N7000

R4
10K

J1

1 TX-BEEP
2 AUDIO-IN
3 PTT-OUT
4
5

HEADER 5

RADIO
CONNECTOR

VR2
10K POT

C5
0.1uF

R2
100K

R3
100K

+5V

VLED

RP2E
470

D10
LED RED

PTT LED
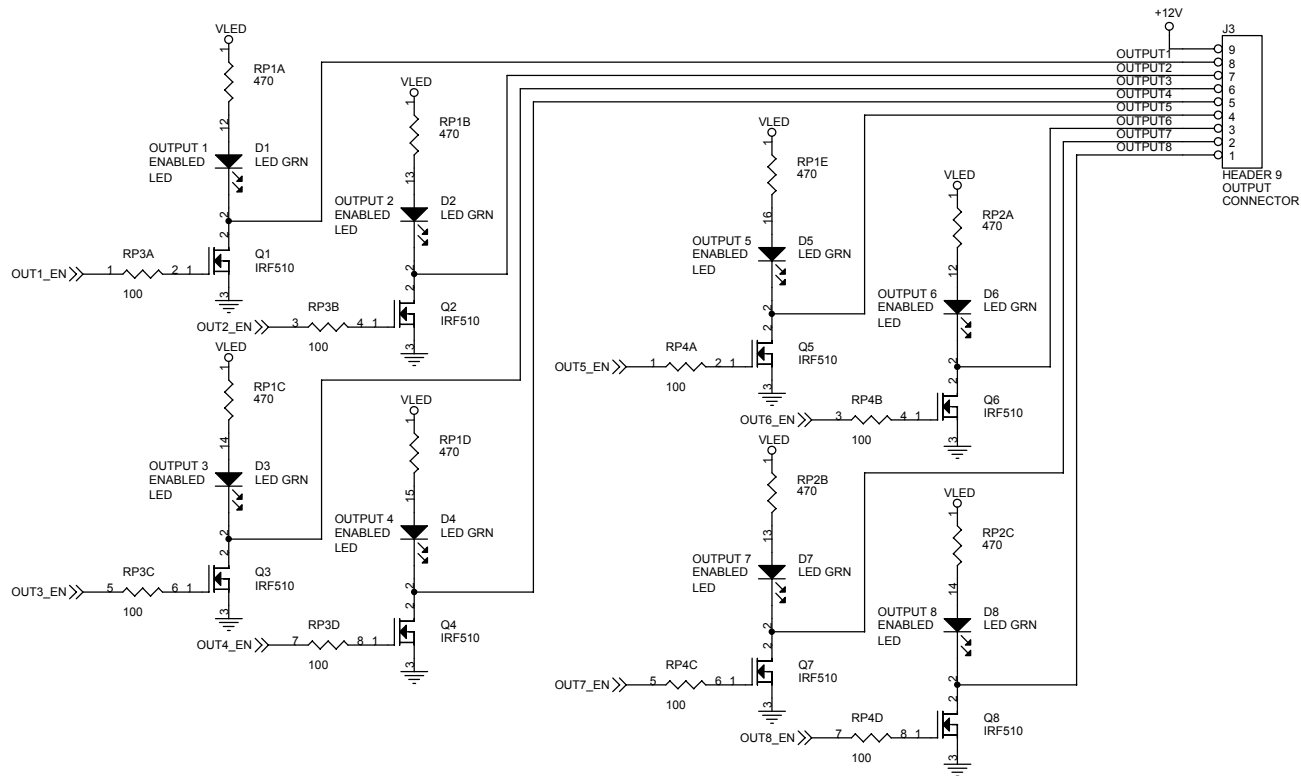
Q10
2N7000

R5
10K

C6
0.1uF

+5V

R6
470K

Y1
3.579MHz

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PCB REV A

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

Title
NHRC-Remote+ Intelligent Remote

Size
B

Document Number

Rev
A

Date: Monday, August 09, 2004   Sheet 1 of 2

J2

1
2

HEADER 2

POWER
CONNECTOR

+12V

C7
22uF

U3
LM7805CT

IN   OUT

GND

+5V

C8
1uF

JP2

1
2

JUMPER
LED ENABLE

VLED

+12V

J3

OUTPUT1 — 9
OUTPUT2 — 8
OUTPUT3 — 7
OUTPUT4 — 6
OUTPUT5 — 5
OUTPUT6 — 4
OUTPUT7 — 3
OUTPUT8 — 2
— 1

HEADER 9 OUTPUT CONNECTOR

VLED — RP1A 470 — OUTPUT 1 ENABLED LED — D1 LED GRN
OUT1_EN — RP3A 100 — Q1 IRF510

VLED — RP1B 470 — OUTPUT 2 ENABLED LED — D2 LED GRN
OUT2_EN — RP3B 100 — Q2 IRF510

VLED — RP1C 470 — OUTPUT 3 ENABLED LED — D3 LED GRN
OUT3_EN — RP3C 100 — Q3 IRF510

VLED — RP1D 470 — OUTPUT 4 ENABLED LED — D4 LED GRN
OUT4_EN — RP3D 100 — Q4 IRF510

VLED — RP1E 470 — OUTPUT 5 ENABLED LED — D5 LED GRN
OUT5_EN — RP4A 100 — Q5 IRF510

VLED — RP2A 470 — OUTPUT 6 ENABLED LED — D6 LED GRN
OUT6_EN — RP4B 100 — Q6 IRF510

VLED — RP2B 470 — OUTPUT 7 ENABLED LED — D7 LED GRN
OUT7_EN — RP4C 100 — Q7 IRF510

VLED — RP2C 470 — OUTPUT 8 ENABLED LED — D8 LED GRN
OUT8_EN — RP4D 100 — Q8 IRF510

PCB REV A

NOTICE

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