

# **N8LP SteppIR™ Tuning Relay\*** **Assembly and User Manual**

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# 1 N8LP SteppIR Tuning Relay

## N8LP SteppIR™ Tuning Relay\* Assembly and User Manual



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## 1.1 Introduction

The N8LP SteppIR Tuning Relay detects when your SteppIR antenna is actively tuning and blocks your amplifier from inadvertently operating until tuning is complete. Locking your amplifier out prevents you from transmitting high power into the SteppIR elements while tuning, which is easy enough to do during the heat of a contest or when pouncing on a web-clutser link. Since FluidMotion rates its SteppIR antennas to 200 watts during tuning, the SteppIR Tuning Relay may prevent an expensive and time-consuming mistake.

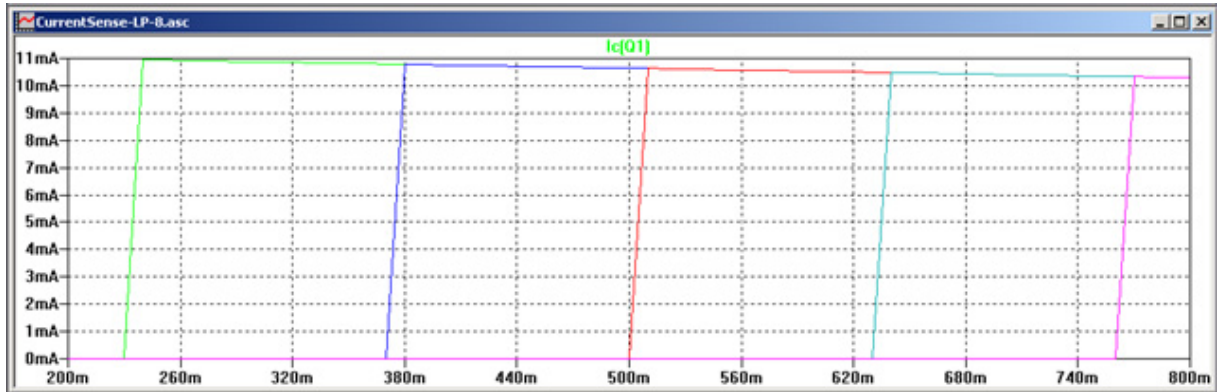
The circuit uses current-sensing to trip a relay when the SteppIR motors are running. The box is placed in the power lead between the SteppIR power supply and the SteppIR controller. One of the main design goals was to provide a device that would be external to the SteppIR controller, and not require internal modifications of the controller.

Refer to the schematic for the following discussion...

The principle of operation is that the current being supplied from the SteppIR power supply to the SteppIR box is sampled by R1, a .33 ohm shunt resistor. The voltage across R1 is compared to a preset level, which is determined by the resistive divider made up of R2, R3 and R5. The sensitivity control, R2, is adjusted so that the relay is just disengaged when the SteppIR is resting and the motors are receiving a holding current. When any motor starts drawing the full running current, the relay will trip and hold until all motors stop running, and the holding current returns.

Normally, your rig grounds the PTT line to key your linear amplifier. The N8LP Tuning Relay box provides normally closed isolated relay contacts that are inserted in series with the PTT line center conductors. The PTT line shield is looped through the box without connecting anything in the box. When the relay opens, the PTT connection to ground is broken, preventing the amplifier from keying. Because the relay is isolated from ground or any operating voltage, it provides a flexible interface to the PTT line. NO and NC contacts are available on the board.

For the PTT wiring I chose to use panel mounted connectors. This allows the user to choose the connectors he needs and wire them as needed. The NC contacts and RCA connectors should work for most rig/amp combos. If necessary, when assembling the kit, the PTT jacks can be wired to the relay differently than this if you need something other than standard PTT wiring. This might be the case if you are running QSK, or wish to totally disable the rig from transmitting during tuning, as opposed to just disabling the amplifier. If you need assistance with alternate wiring options for the relay, you can contact me at [larry@telepostinc.com](mailto:larry@telepostinc.com).



The current set point range was based on info sent to me by Mike Mertel of FluidMotion. The circuit uses a high gain rail-to-rail opamp to increase sensitivity, which allows for an insignificantly low voltage drop (~.6 volt with 4 el SteppIR) and enough pot range to accommodate the various configurations of SteppIR products from a single element to five or six elements. It provides excellent tracking of the current set point (within 2ma) over changes of supply voltage from 24v to 33v, thereby accommodating the two SteppIR power supplies with no need for re-adjustment. The current set point scale is linear and predictable. Above is a graph showing the current trip points at five equally spaced sensitivity pot positions from CCW to CW. The vertical scale is collector current for the relay driver xstr, and the horizontal is SteppIR supply current. The set point for a dipole is about 300ma, and for a 4 element beam about 600ma. The continuous adjustment accommodates installation variables such as cable length and power supply output... plus the ability to use one controller for any SteppIR product.

## 1.2 Assembly

### Assembly of the N8LP SteppIR Tuning Relay

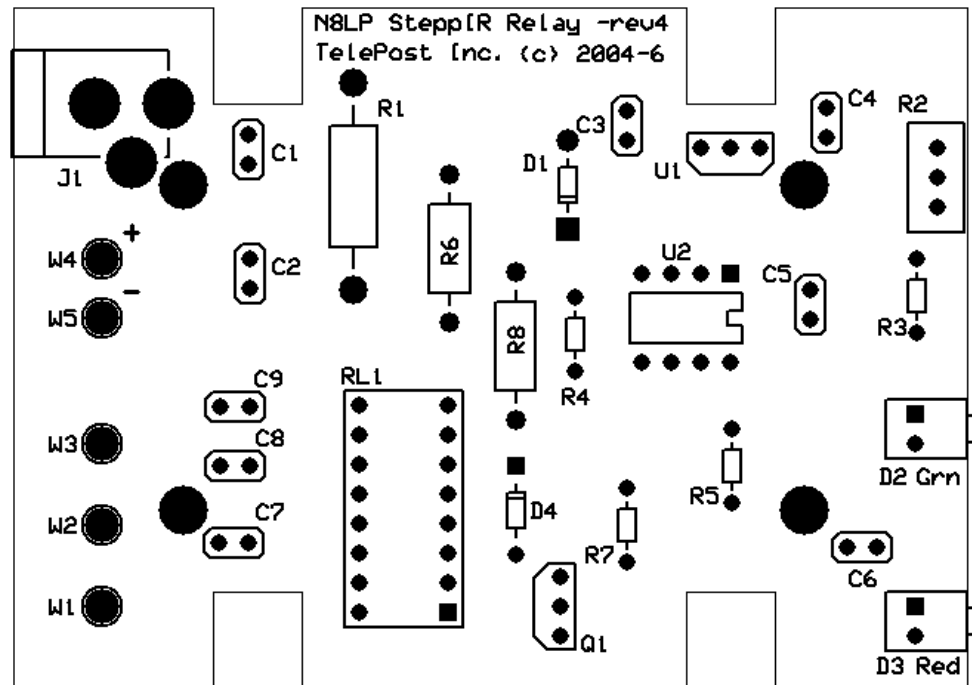
To assemble your kit you will need the following:

15-30W soldering iron with fine tip.  
Thin rosin core solder  
Small needle nose pliers  
Small diagonal cutters  
Small Philips screwdriver

Before assembly, compare the supplied parts against the following list of parts to make sure that no parts are missing. Leave components in conductive foam until you are ready to install them.

C1, C2, C4-C9	0.01ufd ceramic disc cap
C3	0.1ufd monolithic cap
D1	1N4740A zener diode - this is the larger of the two diodes
D2	LED - Green
D3	LED - Red
D4	1N4148 diode - small signal diode
J1	2.5mm Power Jack
J2	2.5mm Power Plug and cable
J3, J4	RCA jack & hardware
Q1	2N4401 xstr - be careful to identify this and U1 by reading their markings since they look alike.
R1	0.33 ohm 2 w resistor - large black resistor
R2	500 ohm variable resistor
R3	10 ohm 1/8w resistor (brown-black-black)
R4, R5	10 kohm 1/8w resistor (brown-black-orange)
R6	3.3 kohm 1/2w resistor (blue body, marked 3.32J)
R7	2.2 kohm 1/8w resistor (red-red-red)
R8	1 kohm 1/2w resistor (brown-black-red)
RL1	Omron G5V-2-H1-12 relay
U1	LM78L05 regulator - observe the same caution as Q1
U2	MCP6041opamp
	8p & 16p DIP sockets (newer boards don't use 16p socket)
	PC Board
	Case, aluminum front & rear panels (plastic panels not used)
	4 adhesive feet & 2 PCB screws

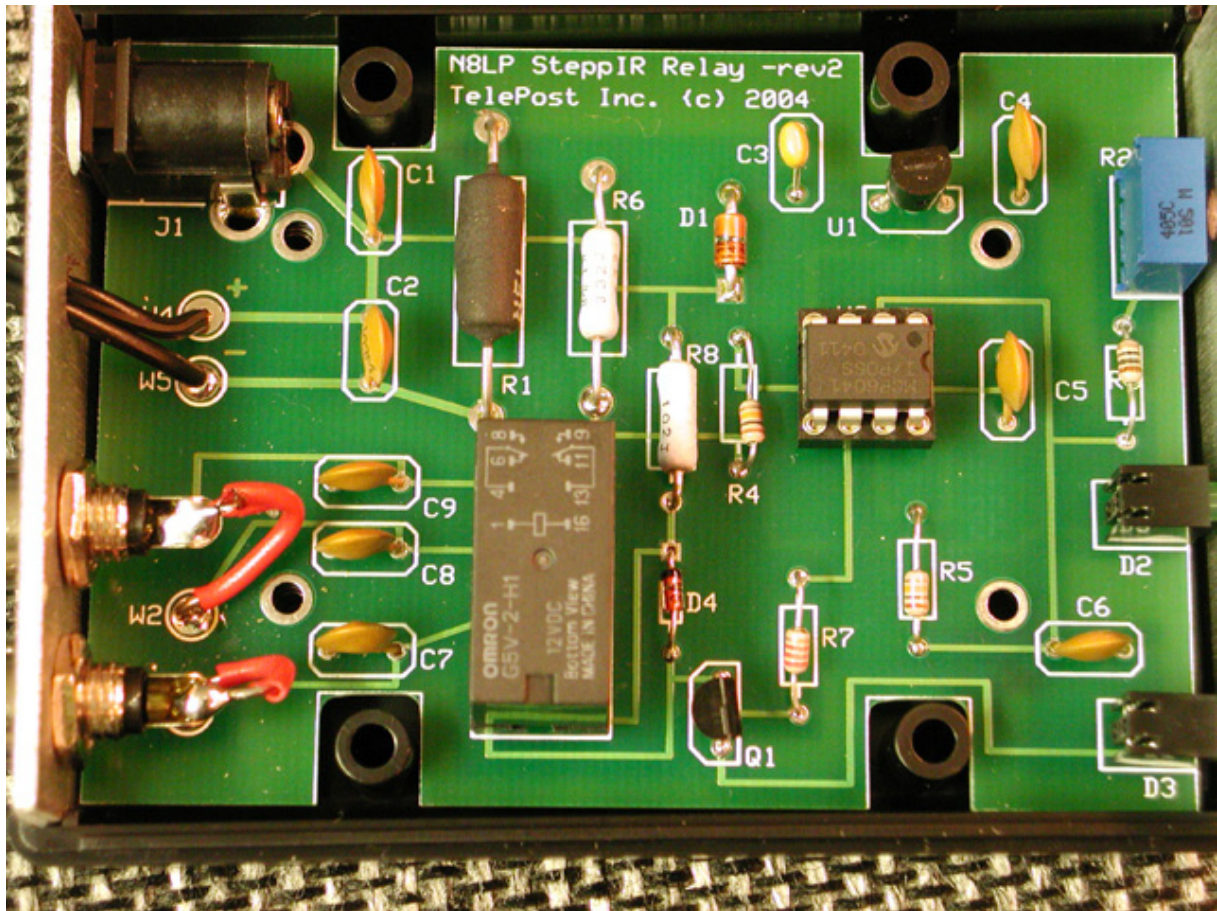
Parts locations for all parts are silk-screened onto the top of the PCB, but there are two mistakes on board version 4. The silk-screening for C3 and C4 are wrong. They are both shown as C8. Use the corrected diagram below for correct placement.



Parts can be assembled in any order, but I recommend installing the DIP sockets first so that the board can lay flat during their installation. Next I would install the caps or resistors, followed by the remaining small parts and finally the socket, LEDs and power plug pigtail. I recommend installing a half-dozen or so parts, clipping the leads, and then adding another half-dozen. Keeping the number of uncut leads to a minimum will make things easier and less cluttered. The PCB has a solder mask which should make assembly easy, but always take care to not apply too much solder.

You should read through this entire section before starting assembly to catch all the tips that will make it easier to assemble the kit. It is also a good idea to refer back to the drawing above periodically. Make sure that your work area is grounded, and that you touch ground before picking up static sensitive components like U1, U2 and Q1.

The following picture of the assembled board is also a good reference for proper parts placement.



When installing the power plug pigtail lead, make very sure that the wire marked with the white stripe (could be either solid or dashed) is connected to the hole with the "+" marking. Before installing the pigtail, you should feed it through the rear panel hole marked "To SteppIR". It is a good idea to tie a small knot in the wire about 1/2" from the tinned ends to provide strain relief, although there is not much stress on the wire. When soldering the power jack, J1, make sure that the jack is parallel to the board and flat against the board. It helps to tack the rear pin to the board before soldering all three so that adjustments can be made.

The RCA connectors can be wired in a number of different ways. The most common way is to wire them as per the schematic. During parts installation, short wires should be soldered to W1 & W2 which will be connected to the center conductors of the RCA connectors later. These wires can be discarded pigtailed from other parts. It is easier to solder these pigtailed from the top of the board. This provides a Normally Closed condition. The shields of the connectors are connected by virtue of being mounted together on the rear panel. Discard the solder tabs from the RCA connectors as they are not needed. Connectors should be tightened from the backside to avoid marring the vinyl text overlay. **NOTE: THE REAR PANEL IS NOT CONNECTED TO THE CHASSIS GROUND of the N8LP SteppIR Tuning Relay.** (The "ground" in the box is actually floating at a fraction of a volt due to the use of a shunt resistor in the ground lead to the SteppIR controller.)

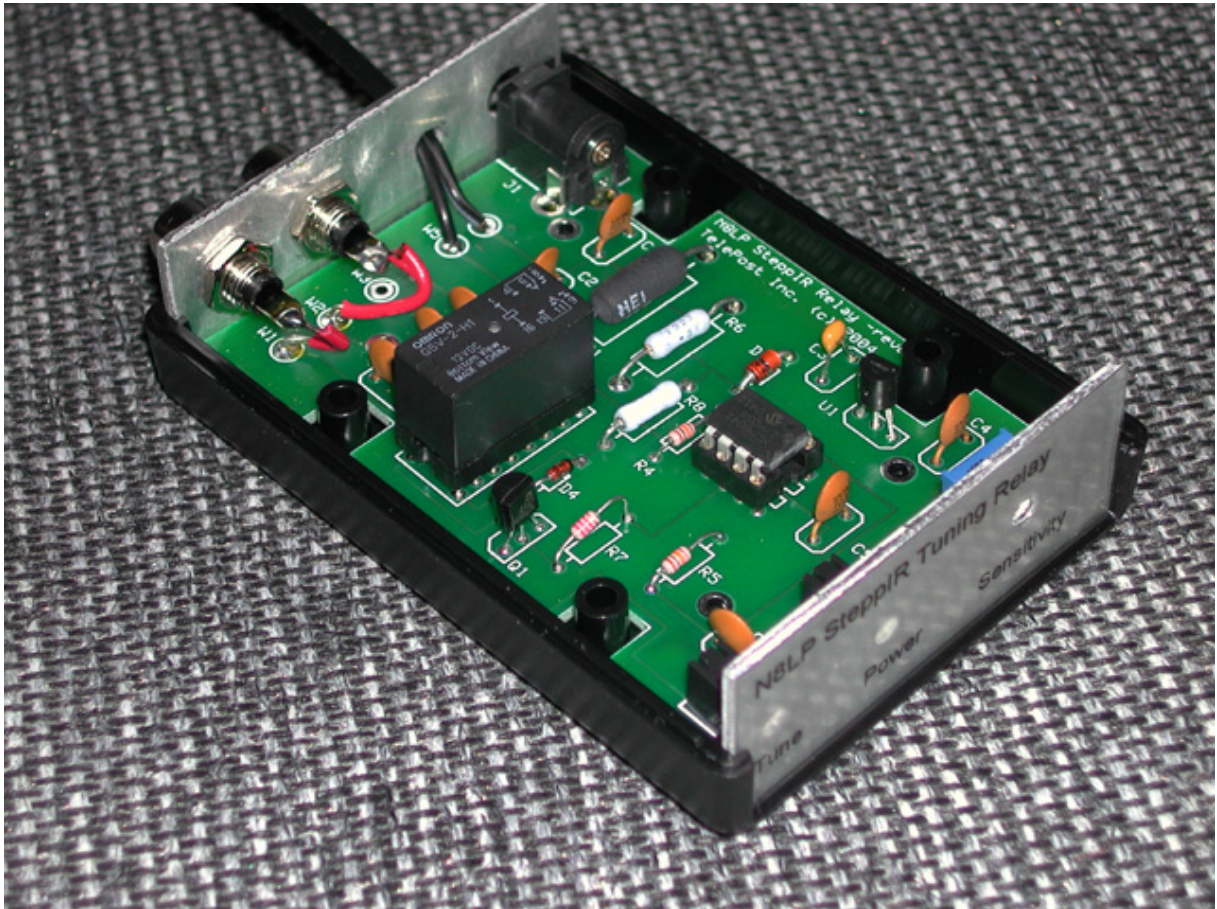


As a final visual check of the board, carefully inspect all parts for proper installation. Here are a few cautions to beware of:

1. Solder bridges... inspect all connections for proper solder flow.
2. Proper orientation of plugin parts... use the above drawing for proper identification. Specific parts to be careful about are U1, U2, RL1, Q1, D1 and D4. For U2 and RL1, pin 1 goes to the square PCB pad. The dimple on U2 should be in the upper right corner of the chip when the board is oriented as shown in the drawing and photo. Note that the drawing on the case of RL1 is backwards (shown from bottom perspective). Position the relay as shown in the photo. On the latest board, RL1 can only be installed correctly. For Q1 and U1, orient the flat side as shown. Also, read the markings on the devices since Q1 and U1 look the same otherwise. This may require the use of a magnifying glass. For the diodes, make note of the marking band which will be on one end of the diode. D4, the 1N4148 diode is smaller than D1, the zener. D1 also has much thicker leads, and will not fit in the holes for D4. In all cases, when in doubt refer to the photo above... all units use the same parts as the photo.
3. Recheck proper wiring of the P1 power pigtail cable.

Once you are satisfied that it is good, the board and panels can be installed in the case. Carefully slide the front panel in place as you set the board into the case bottom. Attach the PCB to the case using the two 4-40 screws provided. I placed my screws behind the pot and the RCA connectors. Next, install the two RCA connectors. Hold the connectors carefully with a pliers as you tighten the nuts on the back. Be careful not to mar the vinyl overlay on the printed side. The connectors should be installed with the "cupped" end facing upward. This will make soldering the pigtails to the connectors easier. Slide the rear panel in place, adjusting the position of the power leads as necessary. Once the rear panel is in place, bend the wires from W1 & W2 to connect to the RCA center conductors and solder. Next, the top can be screwed into place. The top of the case is the slightly recessed side, and the bottom has the countersunk holes. When sliding the case top over the front and rear panels, be careful not to damage the adhesive vinyl overlay. If there is any binding, make sure the slots in the case are clean and no burrs exist. The last step is to place the feet on the bottom of the case. The feet should be placed near the corners on the bottom.

When finished, the unit should look something like the picture below.



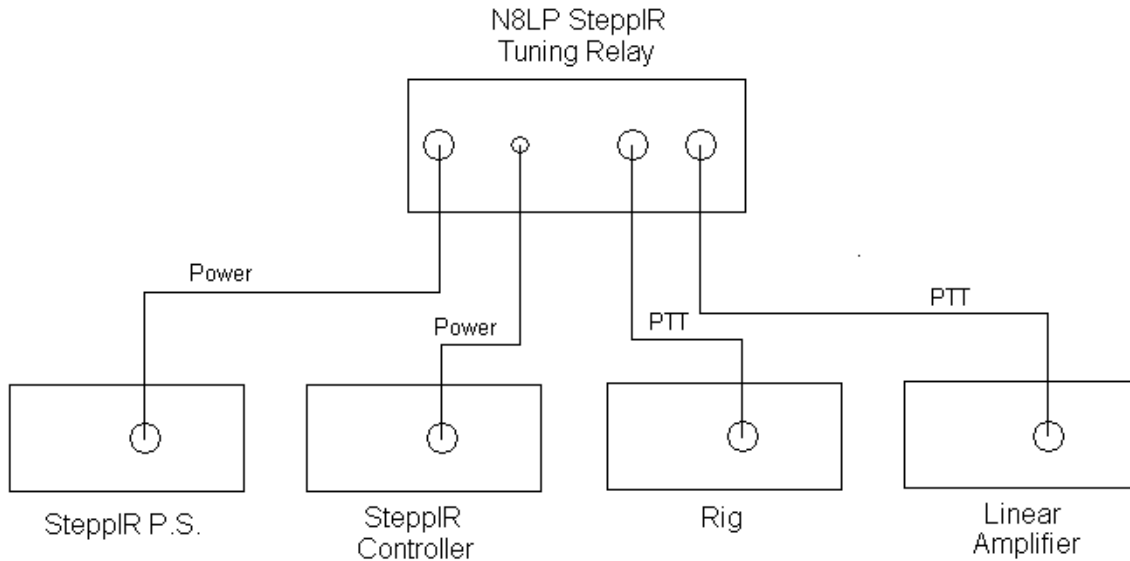
Here are some final checks that can be performed before connecting the N8LP SteppIR Tuning Relay box to your station...

If you have an ohmmeter, double check that the center conductors of J1 and P1 are connected together. Another double-check would be to connect the SteppIR power supply to J1 of the N8LP SteppIR Tuning Relay, and check that there is +24v (or +33v if you have the optional supply) on the center pin of P1.

One further caution... Since the common in the Tuning Relay is floating above ground, DO NOT ever ground the common line inside the box. Under normal conditions this is not a problem since all the external connections to the box are isolated from ground. But it is possible when using a scope, for instance, to accidentally ground the common in the box, which would cause the circuit to not function, because the voltage across the shunt will be zero in that case.

### 1.3 Setup and Operation

The unit is connected as follows...



Remove the power plug from the SteppIR controller and plug it into the N8LP SteppIR Tuning Relay. The green LED on the SteppIR Tuning Relay should light at this point. Now plug the SteppIR Tuning Relay into the SteppIR controller. Turn the SteppIR controller on.

With the SteppIR antenna at rest (not actively tuning), adjust the "Sensitivity" control fully CCW. The red LED should now light. Adjust the control CW until the LED just goes out, and then continue for another 1/8 turn. This should be the optimum set point, and should provide relay actuation when any single motor runs. The approximate pot positions for various SteppIR configurations are listed below.

<u>Pot Position</u>	<u>Configuration</u>
9 o'clock	BiggIR, SmallIR, Dipole
11 o'clock	BiggIR w/80m
12 o'clock	2 el beam
2 o'clock	3 el beam
3 o'clock	4 el beam, MonstIR

Once set, manually tune the SteppIR to verify that the red LED lights whenever the antenna is tuning, and goes out after the tuning stops. This can be verified by watching the tuning "asterisk" on the SteppIR controller. The behavior of the asterisk and red LED should coincide. Once set, the control should never need readjustment.

Once operation has been verified, you can connect the PTT lines. Normally, this can be done by simply removing the RCA connector plugged into your linear amplifier, and moving it to the N8LP SteppIR Tuning Relay. Either connector can be used. Now run a new RCA-to-RCA cable from the SteppIR Tuning Relay to your linear. That's it. To check operation, turn on your linear and key your transmitter now. You should have normal PTT operation. Now force the SteppIR to tune, and the linear should switch to bypass until the SteppIR finishes tuning.

If the box doesn't behave according to this explanation, go to Troubleshooting section.

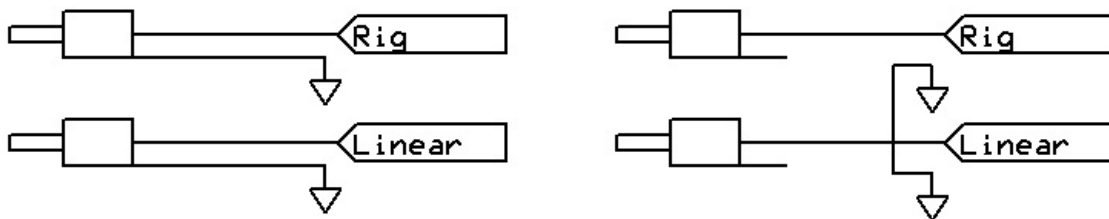
## 1.4 Troubleshooting

Here are some troubleshooting tips if the SteppIR Tuning Relay doesn't work when you fire it up.

Problem:	Check:
Green LED doesn't light	That SteppIR power supply is properly connected to unit. That J1, R6 and D2 are installed properly.
SteppIR controller doesn't function	That P1 is wired properly
Red LED never comes on, regardless of Sensitivity setting	Check all wiring. Make sure U1 & U2 are installed correctly. Disconnect PTT connections and see if problem clears up.

If disconnecting the PTT connections cures the problem, there are several things you can do to remedy the problem, while retaining full functionality of the unit. As mentioned in the Assembly section, the "ground" in the N8LP SteppIR Tuning Relay is floating a fraction of a volt above ground due to the current sensing resistor in the ground lead. This is not normally a problem. If it becomes one, it is because the power connector going to the SteppIR Controller is contacting ground. Normally, the SteppIR Controller power lead is floating. If the paint becomes scraped away in the hole that the power connector slides through, this could cause the power common lead to be grounded. If the SteppIR Controller is also connected to station ground (through the PTT lines), then there becomes a path from ground to the SteppIR Tuning Relay chassis, which bypasses the shunt. This prevents the unit from detecting current changes in the controller. There are a couple of solutions to this problem:

1. Adjust the case on the SteppIR Controller slightly so that the outer conductor of the power connector P1 from the N8LP SteppIR Tuning Relay is not contacting ground. Another solution is to place a small amount of electrical tape inside the hole to insulate it further.
2. Rewire the PTT line so that the shields from the rig and linear are not connected to the shields going to the RCA connectors on the N8LP SteppIR Tuning Relay. Since only the center conductors are needed, this is not a problem. Here are diagrams showing the normal and alternate ways of wiring the PTT plugs...



If the unit acts erratically due to stray RF in the shack, there are a couple of fixes. One is to simply adjust the Sensitivity pot a tiny bit CW. If this doesn't work, placing a ferrite clamp-on suppressor like those found at Radio Shack on the power lead from the SteppIR Tuning Relay should do the trick. An alternative is to loop the power lead through a ferrite toroid, such as a FT82-77.

If the above troubleshooting steps do not solve your problem, contact me at [larry@telepostinc.com](mailto:larry@telepostinc.com).

## 1.5 User comments

Here are some comments from beta testers Bob K8IA, Jon NJ7I and John VE2NFK.

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*"Well, I've been using it all last night and some of the day today as I chase 3B9C DXPedition around the bands. It's worked flawlessly, real cool little box! Purposely moving the SteppIR while keying the amp at 1.5kw output causes the box to switch, as designed, and cut off PTT. If you're still keying and SteppIR stops amp, the PTT is switched on and out comes 1.5 kw agn! Neat.*

*No stray RF problems here for anything so I didnt expect this box to be affected. It isnt.*

*Even when brute forced this thing reponds appropriately and the amp (Alpha 91B) responds in kind. You have a winner here.*

*Its bright red "TUNE" LED offers a much easier to recognize indicator of when the SteppIR stops. MUCHO easier to see than the asterisk in the SteppIR controller. U can see yours out of the corner of your eye, where you have to be looking directly at the asterisk. Neat!*

*I am liking this box, I'll take one ;-)"*

*Bob, K8IA*

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*"The N8LP STR got a workout this weekend in the WPX contest. I did mostly S&P. When S&P and running ASSISTED with the cluster, one can move around... fast. I at times would on purpose key while the SteppIR was tuning and the amp would not kick in till it was done tuning. So cool!*

*The STR box is small so fits well just about wherever you would want to put it. The neatest thing is the tuning BRIGHT RED light that comes on while the SteppIR box is tuning, very nice feature when you are in a hurry, it lets you know to hold on a second.*

*Many times over the weekend DX stations would reply "who is the India". With a weak station I'd be throwing out my call while SteppIR was tuning and then amp would kick in about the time I'd get to the India. I'd chuckle to myself, yea it works!*

*Jon NJ7I*

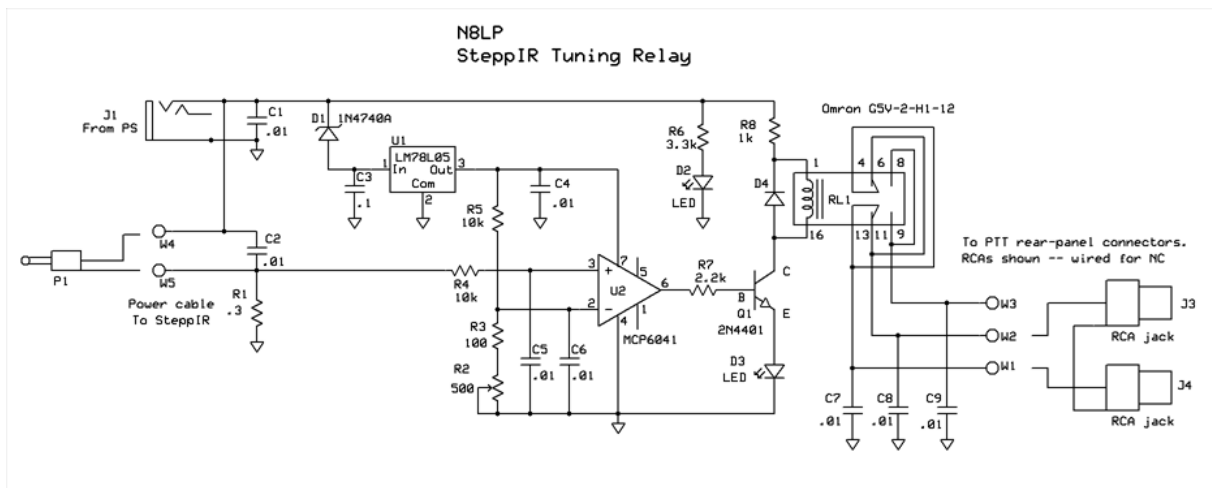
"I have just finished installing the SteppIR Tuning Relay in my system with the 4 Element SteppIR and TS-2000 with a MA1000 Metron 500W out Amp.

Results? Brain-dead easy - works a treat - and the red 'Tune' LED is MUCH easier to see than the little flashing asterisk on the SteppIR controller display.

It shuts off the PTT until the antenna comes to a stop - and then re-energizes it. All-in-all, an excellent addition to the SteppIR family —"

John, VE3NFK

## 1.6 Schematic



## 1.7 Specifications

### N8LP SteppIR Tuning Relay Specifications

DC Power requirement	20-36 vdc @ 50ma maximum (from SteppIR power supply)
Current sense range	Approx. 50ma to 900ma
Current set point stability	< 2ma drift over rated voltage and temp operating range
Voltage drop thru box	Max .7 volts with 2A running current (4 el SteppIR)
Operating temp range	0 to 50 degrees C
Size	2.6"x 1.06" x 3.59"
Weight	5 oz.

## 1.8 Warranty

Factory assembled N8LP SteppIR Tuning Relay boxes are warranted against failure due to defects in materials and workmanship for 90 days from the date of purchase from TelePost Inc. Warranty does not cover damage caused by abuse, accident, improper or abnormal usage, improper installation, alteration, lightning or other incidence of excessive voltage or current. Damage caused by failure of the SteppIR power supply or controller is also not covered.

Units built from kit are only covered against failure due to defects in materials, with the further limitation that any parts damaged as a result of improper kit assembly are not warranted.

If failure occurs within the warranty period, return the *N8LP SteppIR Tuning Relay* box to TelePost Inc. at your shipping expense. The device will be repaired or replaced, at our option, without charge, and returned to you at our shipping expense. Repaired or replaced items are warranted for the remainder of the original warranty period. You will be charged for repair or replacement of the *N8LP SteppIR Tuning Relay* box made after the expiration of the warranty period or where, in our reasonable opinion, the damage is due to improper assembly of the kit.

TelePost Inc. shall have no liability or responsibility to customer or any other person or entity with respect to any liability, loss, or damage caused directly or indirectly by use or performance of the product or arising out of any breach of this warranty, including, but not limited to, any damages resulting from inconvenience, loss of time, data, property, revenue, or profit, or any indirect, special incidental, or consequential damages, even if TelePost Inc. has been advised of such damages.

**Under no circumstances is TelePost Inc. liable for damage to your SteppIR antenna, controller, power supply or other ancillary elements, nor is TelePost Inc. liable for damage to your amateur radio equipment resulting from use of the N8LP SteppIR Tuning Relay, whether in accordance with the instructions in this Manual or otherwise.**