

StepperTune

Remote Antenna Tuner Controller



Instruction Manual

Firmware Version 50K22A December 2016

www.steppertune.com

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Contents	Page
Location Of Controls and Terms.....	3
Introduction.....	4
Installation: Step 1---Connections.....	5
Step 2---Default Settings.....	7
Step 3---Stepper Operating Current.....	7
Step 4---Speed, Capacitor & Inductor.....	8
Jog Width.....	8
Step 5---Limits, Capacitor & Inductor.....	9
Step 6---Learn Transceiver Bands.....	10
Step 7---Auto Band Enable/Disable.....	11
Diagnostic Mode---Band Info, Transceiver.....	12
Stepper Phase Current Test.....	13
Appendix: 1) Using the Memory Buttons.....	14
2) Palstar AT1500DT Tuner Steppers.....	15
3) Directional Coupler.....	16
4) Auto-Tune & Auto-Band Functionality.....	17
5) Transceiver & StepperTune Implentation.....	18
6) Programming Interconnect.....	19
7) StepperTune Operating Voltage.....	19
8) StepperTune Rear Panel.....	20
9) Typical Antenna Tuning Unit (ATU).....	21
10) Internal Parts Locator.....	22
11) High SWR On Coaxial Cable-Not A Good Idea.....	23,24,24

Location Of Controls and Display



Terms:

Location Steps-After the limits are setup, the minimum position will be "0" steps. As the stepper motors are increased in steps (turning), the counters, both capacitor and inductor, will increase in count. StepperTuner memorizes these counts so you may turn the power off and back on and the counters will be the same. Also, StepperTuner uses these step counts to go to memory positions.

Jog Width-When the "Increase" or "Decrease" is pressed, that stepper will move accordingly. Rather than start up at full speed, the stepper starts slowly for a specified number of steps and then ramps up to the set speed. The specified number of steps is the Jog Width.

Amps-This is the current consumed by the last stepper motor that was actuated by the "Increase/Decrease".

Introduction:

The StepperTune Stepper Motor Controller provides a convenient way of operating one or two stepper motors used to control an antenna tuner or antenna tuning unit with stepper motors installed.

The StepperTune Controller allows the antenna tuner or antenna tuning unit to be located at a remote location where the tuner may feed ladder line or any other antenna feedline directly to the antenna with the StepperTune Controller located conveniently in the operators shack.

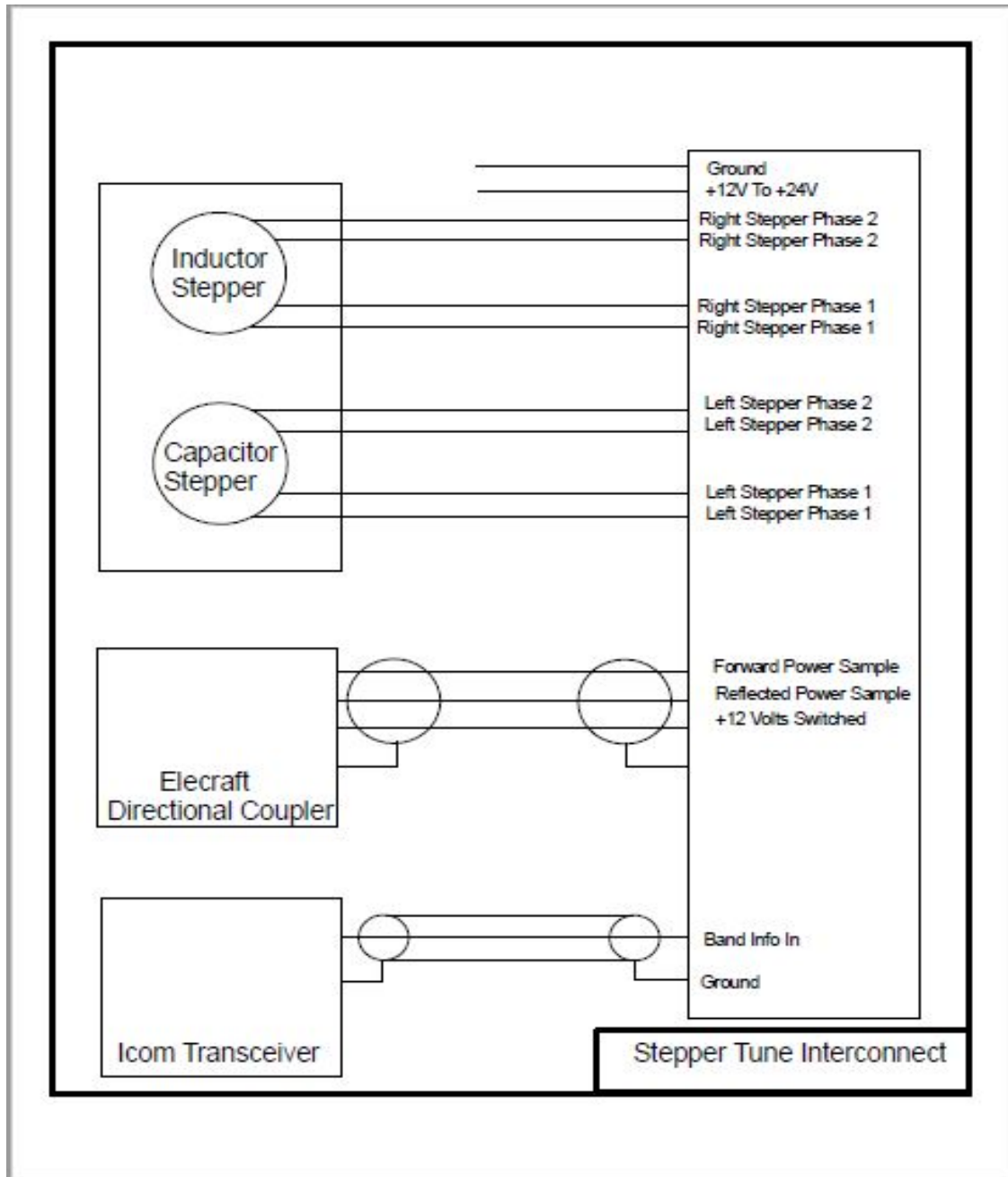
The driving issue is to operate coaxial cable with a low SWR and thus minimize transmission losses. Typically with non-resonant antennas and operating on multiple bands, the SWR will be high on the majority of these bands. By using LadderLine as the feedline with high SWR, the losses (swr loss plus normal loss) will be negligible. Likewise the coaxial cable from the tuner to the shack will show minimal loss.

StepperTune Features:

- Designed To Control Two Stepper Motors For Controlling A Remotely Located Antenna Tuner.
- May Remotely Control Tuning Capacitor For Magnetic Loop.
- Control Cable May Be Cat5 Cable Up To 200 ft while Using A 12 Volt Power Supply.
- Cable Lengths Greater Than 200 ft May Be Realized Using A Supply Voltage Up To 24 Volts DC.
- Eight Memory Locations For Both Steppers.
- Auto Band Memories For Auto-Band Change From Icom Transceivers (other transceivers may be implemented with a band decoder module upon request.
- Automatic Antenna Tuning Capable With External Specified Directional Coupler Connected.
- Stepper Motor Current Control and Stepper Motor Current Displayed. Capable Of Up To 2.5 Amps of Stepper Drive Current.
- Stepper Over-Current/Over Temp Shutdown Protection.
- "Jog Mode" To Easily Fine Tune Either Stepper Motor.
- Stepper Motor Speed Easily Programmed.

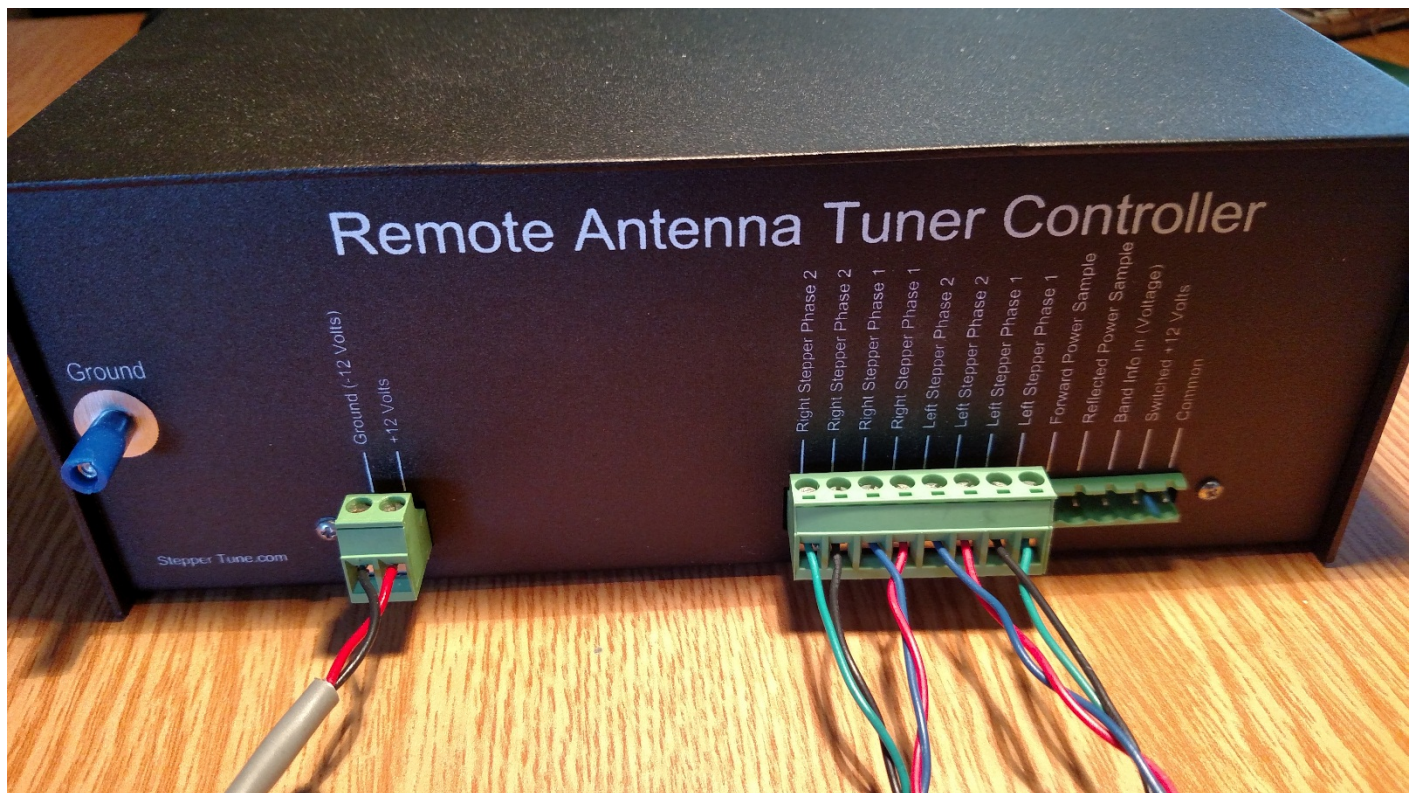
Installation:

Step 1: Connect power and stepper motor cables to the controller as shown in the following connection diagrams:



Installation Continued:

It is recommended the StepperTune be connected to the stepper motors (Tuner) with a short (3 foot cable) so the motors may be observed in operation.



To make connections to the Phoenix terminals, use a 1/8" flat blade screwdriver to:

1. Unplug the connector from the rear of the StepperTuner.
2. Turn the terminal screw counter-clockwise to open the connection point.
3. Plug the stripped wire into the opening.
4. Turn the terminal screw clockwise to clamp down on the stripped wire.

Repeat for all connections on the Phoenix connector as shown in the connection diagram above. Pay special attention to the *polarity* when wiring the two-terminal DC-Power Block or damage will occur to the controller.

Installation Continued:

The following setups must be initially performed in this strict order:

Step 2: Preset Default Settings (stepper speed, etc) by Holding M1 + M2 + M3 while turning the StepperTune on. “Defaults Loaded” will be displayed until you release the buttons. Turn the StepperTune off.

Step 3: Stepper Motor Operating Current by holding M2 + M4 while turning the StepperTune on. Then use M2 to increase the target current and M4 to decrease the target current. This setting range is 0 to 2.5 amps.



Once you have set the proper operating current for your particular motor, press the Auto-Tune button to begin the current ramp up. Once the desired current is reached (Target Current), the StepperTune will save the result and revert back to normal operating mode.

Target Current: M2=Increase, M4=Decrease.
Press-Auto Tune=Auto Current Ramp Up To Target:



This completes the preliminary settings. Now you may begin testing your stepper motors. If you have not set the current high enough for the load your motor is turning, the motor may skip steps. The same applies if you run your motor too fast. I suggest you go to Page 13 and perform a phase test.

Installation Continued:

Step 4: Speed-Capacitor, Inductor & Jog Width by holding M2 + M3: Press M2 to increase the speed setting and M4 to decrease the speed setting (2 to 200 range). Once you have set the speed value required, press Auto-Tune to save the setting:

Capacitor Speed Set Using M2 (Increase) and M4 (Decrease)



Once the Capacitor Stepper Speed has been saved the Steppertune will proceed to the Inductor Speed setting:

Press M2 to increase the Inductor speed setting and M4 to decrease the Inductor speed setting (2 to 200 range). Once you have set the speed value required, press Auto-Tune to save the setting.

Inductor Speed Set Using M2 (Increase) and M4 (Decrease)



Once the Inductor Stepper Speed has been saved the Steppertune will proceed to the Jog Width setting:

Installation Continued:

Press M2 to increase the Jog Width (slow speed at beginning of stepper motor run) and M4 to decrease Jog Width. Once you have set the value you wish, press Auto-tune to save this value into memory.

Jog Width (1 to 25) Using M2 to Increase Count and M4 to Decrease Count. Press Auto-Tune to Save the Jog Width setting.



Step 5: Limits for Capacitor and Inductor by holding M1+M2 while turning the StepperTune power on and then release buttons:

Capacitor and Inductor Counts are set at mid range so both steppers may be adjusted to physical minimum limits.



Press Capacitor Decrease to move the Capacitor in the tuner to minimum capacity where you wish it to stop as a limit.

Press Incuctor Decrease to move the Inductor in the tuner to minimum inductance where you wish it to stop as a limit.

POWER DOWN THE STEPPERTUNE.

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Installation Continued:

While Holding M3+M4 Power Up StepperTune and release the buttons. The Display will indicate 0 for both capacitor and inductor position (steps):



Press Capacitor Increase to take the capacitor to maximum capacitance. This is the capacitor setting where the Steppertune will stop for maximum capacitance. Then press Inductor Increase to maximum inductance. This is the inductor setting where the Steppertune will stop for maximum inductor.

Power Down StepperTune.

While Holding M1+M4 Power Up StepperTune which will save the limits previously set into memory and “Max Limits Saved” will be displayed.

Step 6: Learn Transceiver Band Info: While holding Capacitor Increase + Capacitor Decrease and Power Up StepperTune will memorize band info voltage for each operating band (160M, 80M, 40M, 20M, 15M, 10M):



The display instructs to set the transceiver to 160 Meters and press Auto-Tune to memorize this voltage. StepperTune will then display the same function for 80 Meters waiting for Auto-tune to be

Installation Continued:

pressed and on through to 10 meters each time changing the transceiver to the associated band indicated on the display. *Note: The transceiver must be connected to the rear terminal strip of the StepperTune as described on page 5.*

Step 7: Auto Band Enable/Disable by holding Inductor Increase+Inductor Decrease and release the buttons:



Press M2 to go to this screen:



Press M4 to go to this screen:



Installation Continued:

Press M2 to toggle AUTOBAND(M2)=0 to 1. Continue to tap M2 will toggle it between 1 and 0. 1 indicates autoband is enabled and 0 indicates disabled.

When finished with the setting, tap Auto-Tune to save to memory.

Note: it is assumed you have memorized band voltages (page 10) for each band before enabling this function.

Diagnostics:

Band Info Of Transceiver: Hold Inductor Increase + Inductor Decrease and Power Up StepperTune. After memorizing band info (voltage) for each band you may look at the band decoder to be sure it is working properly.



Then Tap M1 to go into Band Test Mode. You should see the Band your transceiver is on in the StepperTune top line of the display.



Tap Auto-Tune to finish Band Test.

Diagnostics Continued:

Stepper Phase Current: Hold M1+M3 while Powering Up StepperTune. This mode will test each of two phases with one polarity and then the reverse polarity for both motors. The display top line shows which test is being performed and the bottom line shows the operating current for that particular test. The test is initialized by tapping Auto-Tune and advanced also by tapping Auto-tune:

There are 8 tests (4 tests for motor one and 4 tests for motor two):

- 1) M1 C1+ Power On (*motor 1 phase 1 normal polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 2) M1 C1- Power On (*motor 1 phase 1 reverse polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 3) M1 C2+ Power On (*motor 1 phase 2 normal polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 4) M1 C2- Power On (*motor 1 phase 2 reverse polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 5) M2 C1+ Power On (*motor 2 phase 1 normal polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 6) M2 C1- Power On (*motor 2 phase 1 reverse polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 7) M2 C2+ Power On (*motor 2 phase 2 normal polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)
- 8) M2 C2- Power On (*motor 2 phase 2 reverse polarity, Power Applied*)
Current=XX (*current display for this motor and phase*)

If you have a motor issue, a lack of current should show up on at least one of the phases. This may be caused by a cabling issue or it may be an H-Driver issue. This test is contingent upon setting the proper current in step3-Page 7.

Appendix:

1) Memory Useage:

Memory Storage:

Button	Bank A (hold for 2 seconds and the display will indicate)	Bank B (hold for 4 seconds and the display will indicate)
M1	Memory 1	Memory 5
M2	Memory 2	Memory 6
M3	Memory 3	Memory 7
M4	Memory 4	Memory 8

When the memory location you want to store appears on the display, release the button. For example, if you want to store both Capacitor and Inductor positions in Memory 7, press and hold the M3 button for four seconds and release it when “Memory 7” appears on the display.

Once the tuner positions are memorized, both counts will be displayed along with the memory location.

Memory Recall:

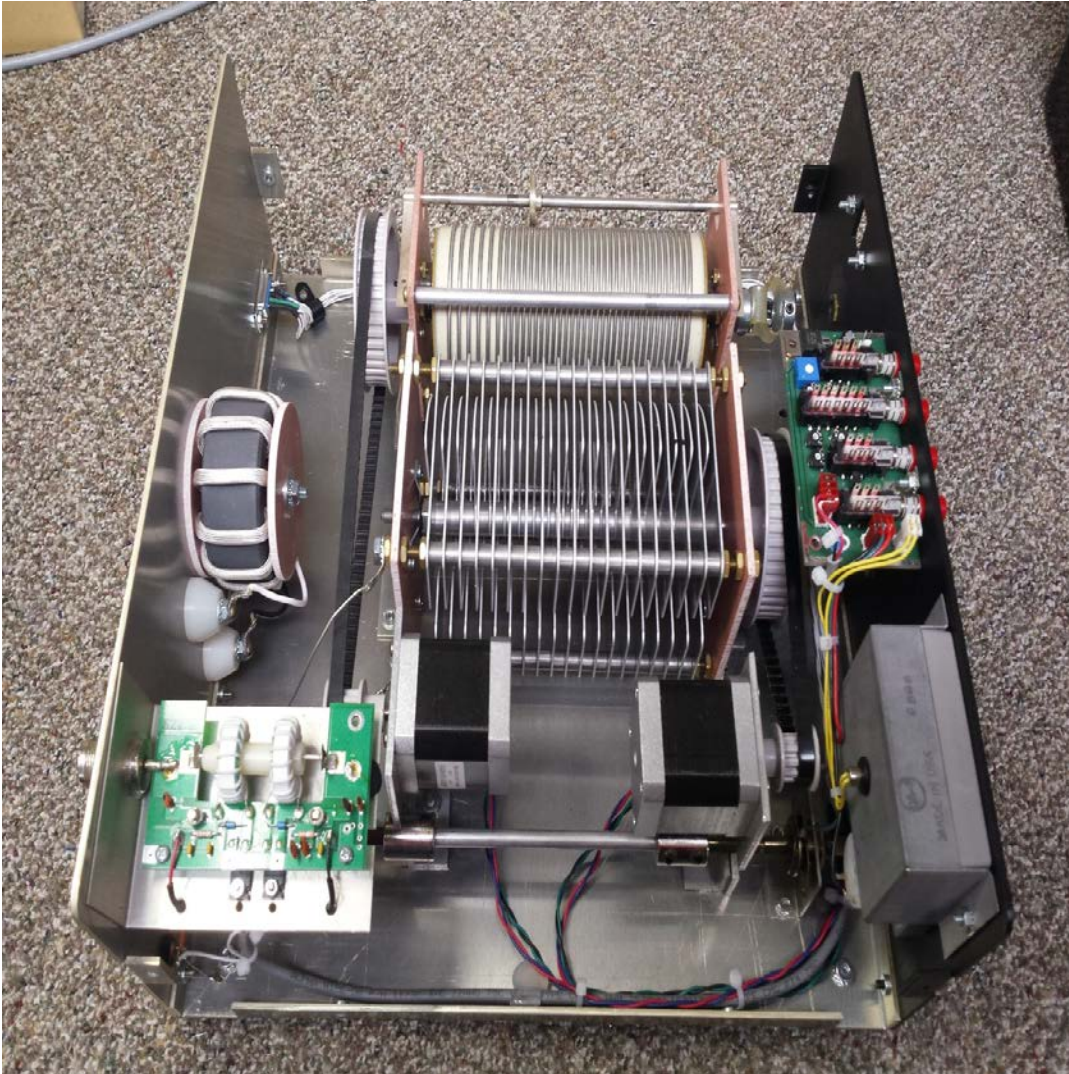
To recall memory positions 1 through 4 (Bank A), a “single tap” of the M1, M2, M3 or M4 button is required. When you tap once, you will see dashes progress across the display followed by an asterisk and then the memory location as follows:

-----* and then the memory location will be displayed. For example, suppose positions [(Cap) 235 (Ind) 3476] is stored in Memory 4. To recall Memory 4, tap the M4 button. The display will show: -----* followed by [235 M4 3476].

To recall memory positions 5 through 8 (Bank B), a “double tap” of the M1, M2, M3 or M4 button is required. When you tap once, you will see dashes progress across the display. Hit the second tap the moment the asterisk appears. Think of a “doubl-tap” as being similar in timing to a “double-click” of a mouse to start a software application on your computer. There is a video demonstration of the “double-tap” technique on the StepperTune.com website.

Appendix Continued:

- 2) **Palstar AT1500DT Modified For Remote Control With Stepper Motors.** Parts for this modification available upon request:



Recommended Stepper Motors: 42BYGHM810 (Other Bi-Polar Steppers May Be Used)

Appendix Continued:

- 3) **Directional Coupler Recommended** which provides forward and reflected power signals connected to rear apron of StepperTune. This coupler requires 12 volts supply voltage which is supplied at rear apron of the StepperTune also. This supply voltage is switched by the StepperTune front panel power switch.



Elecraft DCHF-200 Directional Coupler Used For Auto-Tune Feature

Appendix Continued:

4) Auto-Tune Functionality:

There are two parameters that must be met for the Auto-Tune to perform---a transmitter carrier power range of 10 watts to 20 watts and secondly, a SWR of 2:1 or less. If either of these parameters are not met, the controller will display the issue and not perform the auto-tune. The purpose of the SWR limitation is primarily due to the wide swings in SWR during tuning that may occur which will cause the transmitter to either shut down or go into fold back. Both of these conditions causes a logic upset for the microprocessor. Also, a wide range auto-tune may cause a long waiting period due to the size of the roller inductor.

To initiate an auto-tune, simply tap the “Auto-Tune” push button. It is recommended that the operator install a directional wattmeter at the output of the transceiver to monitor the auto-tune and to manually adjust the two stepper motors for low SWR.

If you find the auto-tune process to be slower than you wish, you may halt the process by pressing and holding the “Auto-Tune” button. Depending on where the controller is in the “Auto-Tune” cycle will dictate how long before a “Halt Auto Tune” indication will be displayed.

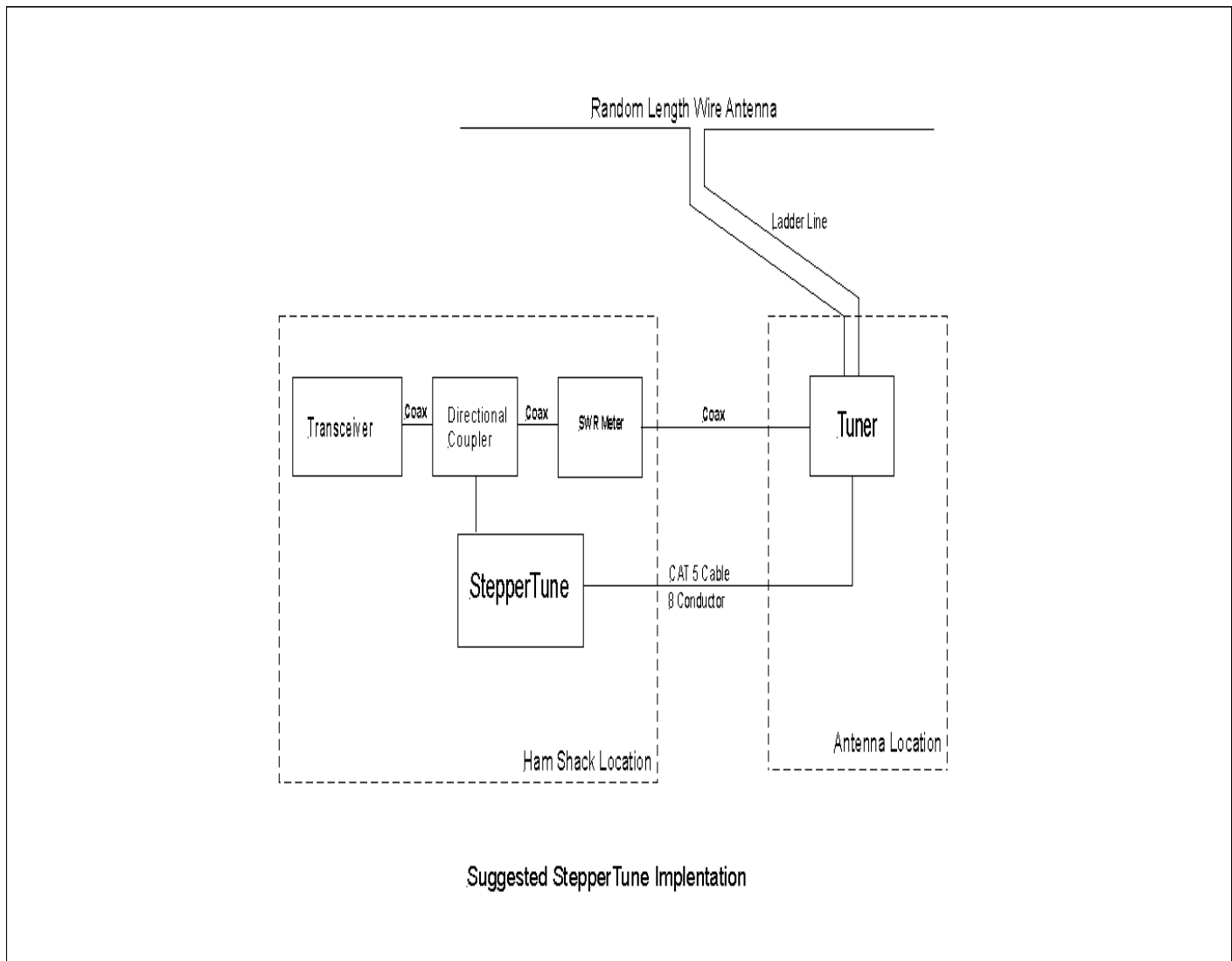
The Auto-Tune function requires an Elecraft Directional Coupler be installed between the transceiver and the tuner (Coax) and a control cable connected between the Directional Coupler and the StepperTune as indicated in the wiring diagram on Page 5.

Transceiver Auto-Band Function:

Operationally, as the transceiver band is changed, the StepperTune will follow the radio and make preset adjustments (memorized) to the Capacitor and Inductor for each band when enabled in StepperTune. The StepperTune is designed for direct connection from Icom Transceivers. Other transceivers will require a small decoder module which may be available upon request.

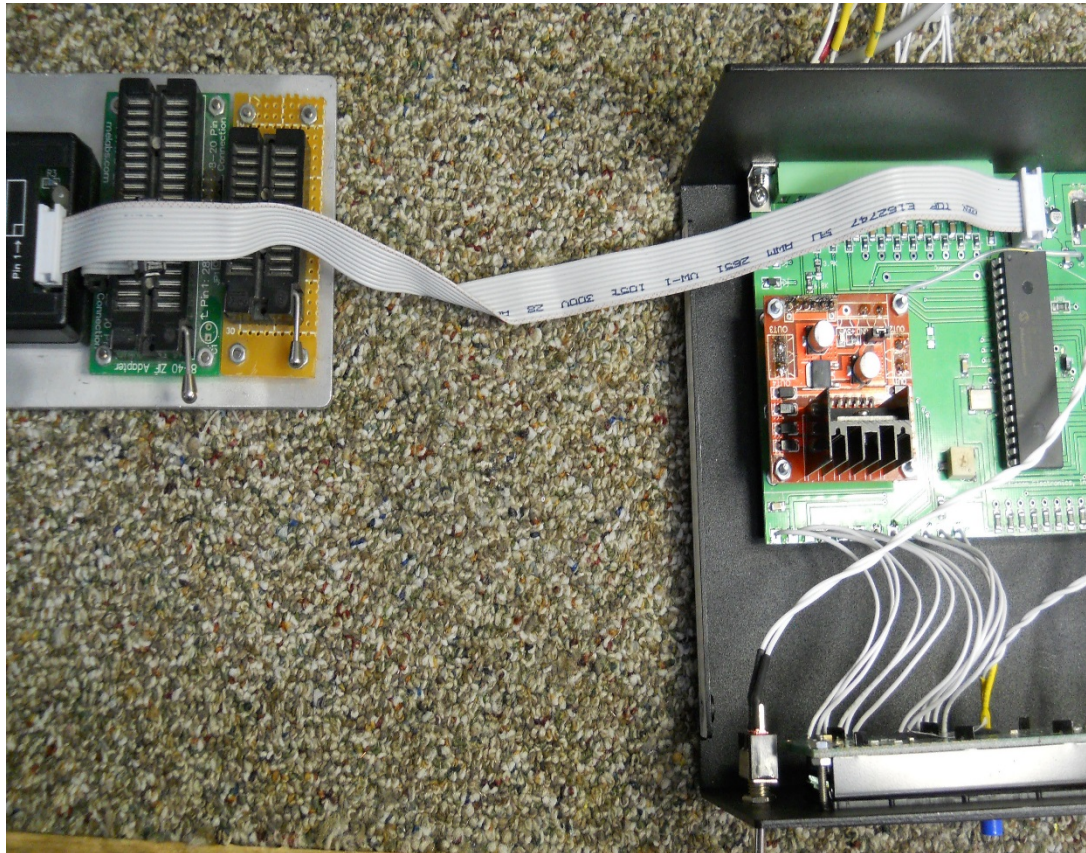
Appendix Continued:

- 5) We recommend you connect your transceiver through an analog SWR Meter so small changes in SWR may be monitored allowing inductor and capacitor adjustments easily:



Appendix Continued:

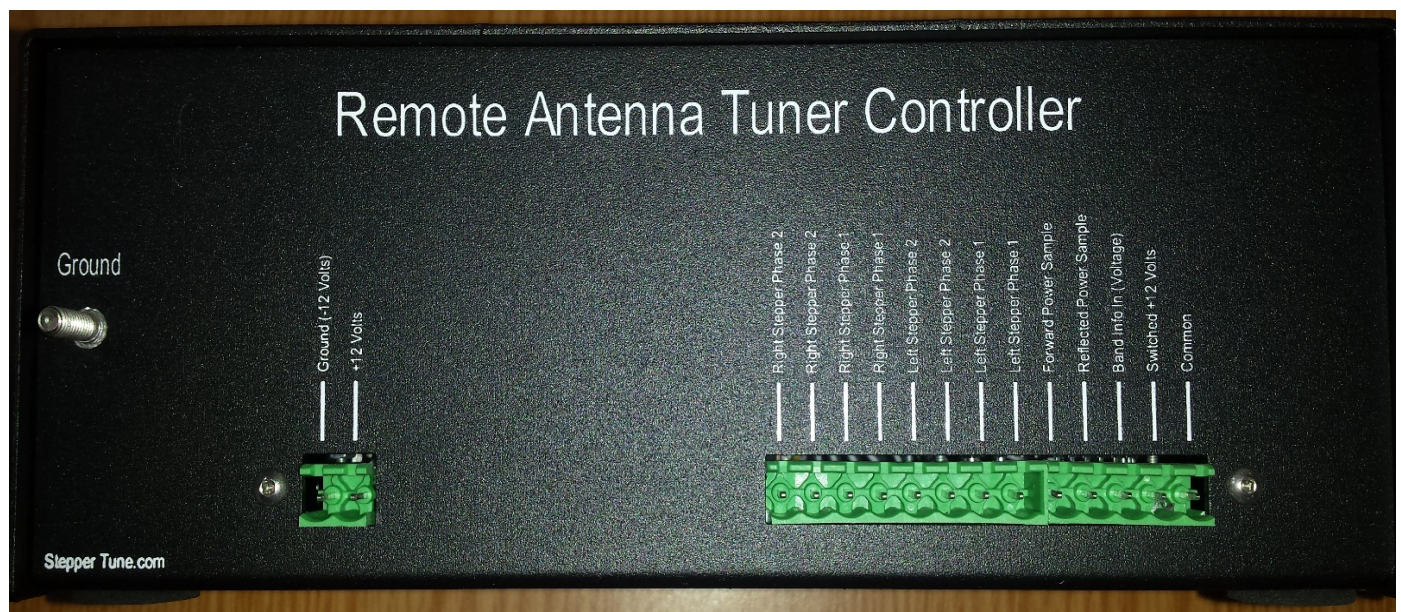
6) Programming Interconnect:

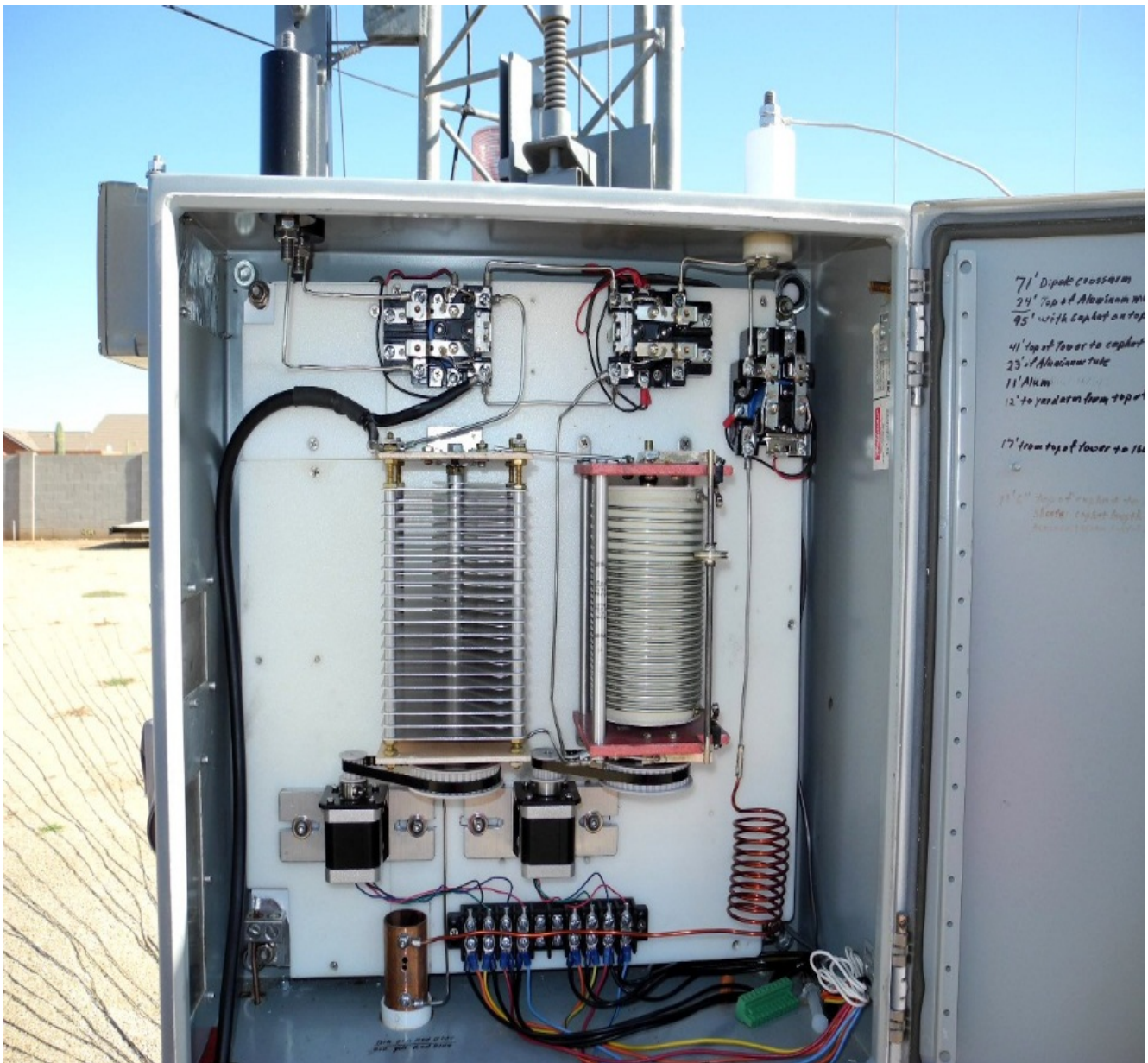


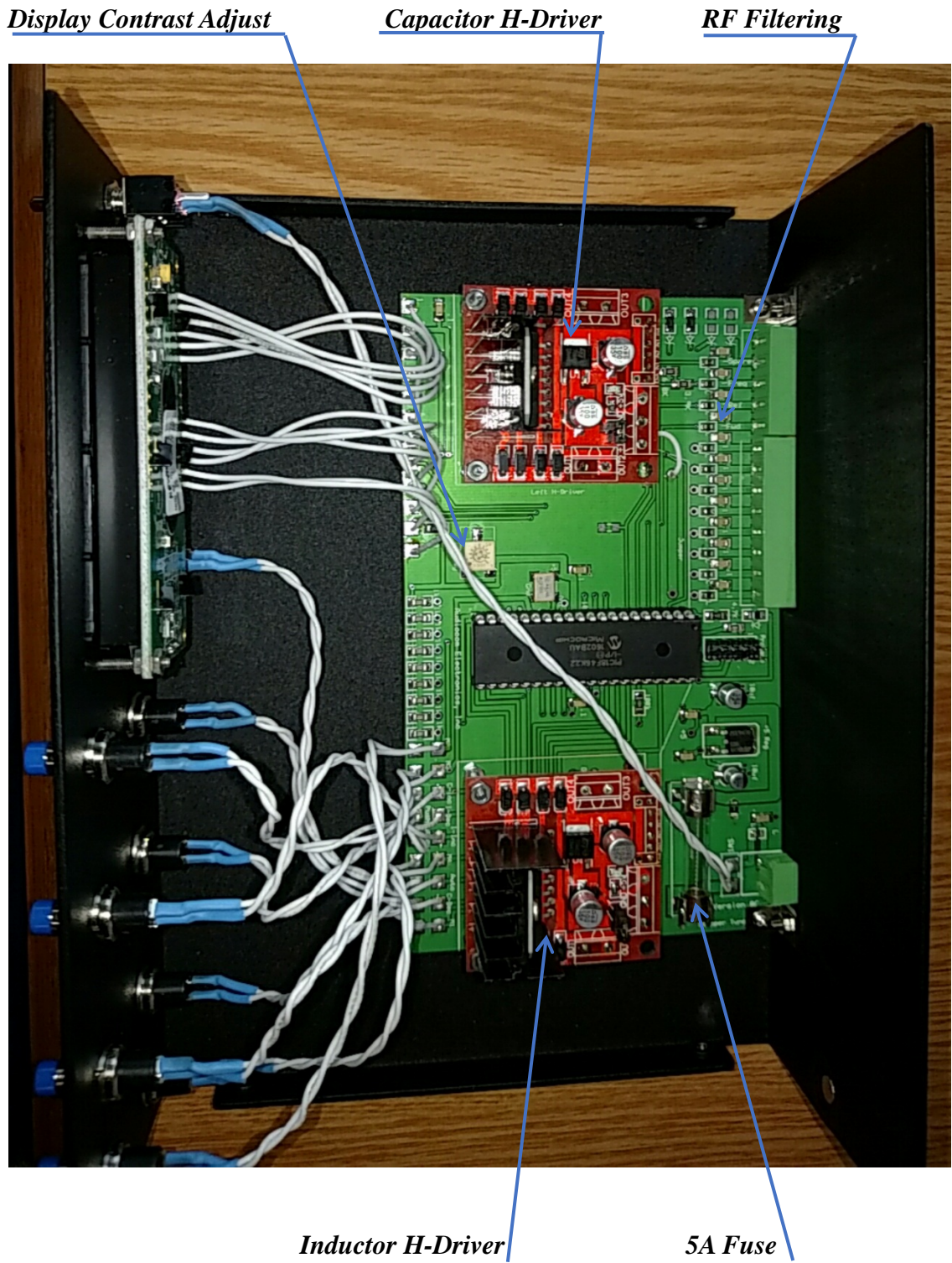
- 7) Typically the supply voltage for the StepperTune is 13.8 Volts DC. With this supply voltage the recommended stepper motor may be driven via CAT5 cable up to 200 ft. If you need to operate over a longer cable run the operating current may not be acquired (step 3-page 7). With the excessive voltage drop on a long cable run, you may increase the supply voltage to the StepperTune up to 24 Volts DC. Once the supply voltage is increased, it is necessary to setup the operating current again (step 3-page 7).

Appendix Continued:

8) Rear Panel Connections:



Appendix Continued:**9) Antenna Tuning Unit (Remote At Tower) At The NI7J Station-
Scorpion Antennas (Controlled by StepperTune):**

Appendix Continued:**10) Internal Parts Locator:**

Appendix Continued:**11) *High SWR On Coaxial Cable-Not A Good Idea***

History: Amateur radio operators before WWII used ladder line to feed their antennas. Transmitters incorporated link coupling to feed ladder line which provided a very efficient transmission system. With this system they were able to feed one wire antenna on multiple bands and did not concern themselves with making the antenna resonant nor did they get overly concerned about SWR because losses were minimal. Their primary concern was to be able to “load” their transmitter into the feed line and they could not use sharp bends in the ladder line nor could they place the ladder line underground or near metallic objects.

After WWII coaxial cable became available as surplus and the amateur community adopted it's use in a big way because it could be buried, bent and close or on metallic objects. This made using feedline much easier and convenient. The negative feature of coax cable is the loss incurred primarily due to the dielectric material around the center conductor. Many of us to this day have chosen to ignore these losses and compromise our transmission systems. High loss is not a significant issue if the cable run is short. If the run is long, the losses can be significant. High quality (and expensive) coax is manufactured that boasts air dielectric in lieu of PTFE or foam. This type of coax is not flexible and therefore limited in application but is low loss but not feasible for the average amateur radio operator.

SWR Loss: In broadcasting we operate on one frequency and therefore can operate an antenna that presents a 50 ohm non-reactive load to the coax and thus an SWR of 1:1 or close to that. With this type of installation the feedline losses are those of the line only.

We who operate within the amateur radio community wish to operate on a wide range of frequencies and with limited resources wish to use one wire antenna. This is problematic if using coaxial cable. Some have suggested using some “magic” length of coax and maybe an impedance matching transformer between the antenna and feedline. This all is a compromise at best because the mis-match between the antenna and coax varies depending on the frequency of operation. Also, the longer the coax run (and higher the loss), the better the SWR “looks” which here again the operator is fooling himself /herself. So in reality, total feedline loss is the summation of specified feedline loss and SWR loss. The higher the SWR the higher the SWR Loss!

Moderately long coax runs can display loss as high as 3db even when properly terminated. This means that with 100 watts from the transmitter 50 watts will be delivered to the antenna. Most amateur transceivers can tolerate an SWR of 2:1 but any higher than this and the transceiver starts into fold-back to protect the output stage of the transmitter. By feeding a wire antenna with coax and operating on frequencies from 1.8 Mhz to 29 Mhz, the SWR can easily exceed 10:1.

Appendix Continued:

By adding the coax loss and SWR loss together, one can easily show a loss of 6db (that yields 25% of the power to the antenna). Also, this kind of loss means 75% of the power is being dissipated in your

feedline system which means if you are running legal limit you are stressing your transmission system big time.

Solution: Install very inexpensive ladder line which shows losses within a few tenths of a db! Feedline loss is low and high SWR losses are negligible! The antenna/feedline system is comprised of a random length wire antenna (not necessarily resonant) fed with ladder line directly. Because the transceiver uses an unbalanced (coaxial) output, a transitional box called an antenna tuner is required. The antenna tuner will need to feed a balanced feedline (ladder line) and the tuner may be located near the transceiver if the ladder line can be gracefully fed into the radio room.

If the antenna is located a significant distance from the radio room and perhaps you wish to install the feedline under ground or attached to metallic supports, there is still a solution by using ladder line. You may use ladder line from the antenna feedpoint down to the antenna tuner mounted in a weather proof box below the antenna and from the tuner—coax back to the radio room. With this type of installation, one may also use an L-Network tuner to feed a single wire to the antenna (like a Windom or longwire). This system is also applicable to shunt feeding your tower with a slant wire.

By remotely locating the antenna tuner presents another problem-how can it be tuned from the radio room. Some amateurs use an automatic tuner remotely located but that presents the problem of power and control cable. Many amateurs prefer to build their own antenna tuners with great satisfaction but here again controlling them remotely has been a big drawback with this approach. This problem stimulated the development of StepperTune. StepperTune is capable of controlling two stepper motors remotely so one can fabricate a tuner and add stepper motors for control or install stepper motors in an already fabricated tuner. StepperTune memorizes the location of each stepper so it is capable of adjusting both steppers to preset positions for automatically acquiring low SWR for a particular operating frequency (8 memories for both steppers). StepperTune also is comprised of 8 memories used as a “lookup table” to automatically acquire stepper preset positions based on transceiver band information. StepperTune also can “fine adjust” the steppers for low SWR automatically.

Appendix Continued:

StepperTune Interconnect Cable: One CAT5 cable (8 conductors) is required to control your tuner with StepperTune. 200 ft of CAT5 is possible using a 13.8 volts DC supply. If one wishes to use a longer run of CAT5 simply increase the supply voltage up to 24 volts DC. The other option for a longer run would be to use larger gauge conductors in the control cable.

Stepper motors may not be over driven with excessive current. If overdriven on a regular basis the permanent magnet field can be de-magnetized rendering the motor useless. StepperTune has a current control function allowing the operator to “load in” a target operating current and StepperTune will acquire that current level and memorize it for normal operation.

Each stepper (bipolar) has four conductors (two windings) which are fed by StepperTune. Each winding receives both polarities which yields eight different drive situations from the H-driver within StepperTune. If one encounters a stepper problem it can be a formidable diagnostic problem. StepperTune is capable of running diagnostics on the H-driver, interconnecting cable and stepper.

Ladder Line Types: Ladder Line loss is primarily dictated by the dielectric material holding the spacing of the two conductors. More dielectric as in “TV twin lead” translates to more loss. “Window Line” has less loss than “twin lead”. Ladder Line using a single “spacer” at a specified interval will have the lowest loss. Building your own line is very feasible and a very elegant design is to use a design length of plastic tubing with a tie wrap looping through the tubing (both ways) and clamping each conductor on each end of the tubing. Ladder Line impedance is a function of the conductor diameter and spacing which is available in the ARRL handbook.

I know you will be pleased with your new Ladder Line! 73's, Gary Baker K7EMF