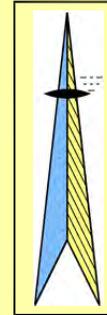


A PRODUCT OF

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OPERATIONS AND ASSEMBLY MANUAL

FOR THE

**RST-8710 VHF DIPOLE ANTENNA
*SORTA-KIT***



Edition: 14 Jan 2014
Part Number: 4-8710-8101
Print Date: 14 Jan 14

Purchase Date: _____

A. INTRODUCTION

Welcome to the RST line of Sorta-Kits® -- it's sort-a kit, and sort-a-not-a kit. In an attempt to keep your cost of our products to a minimum, a Sorta-Kit is supplied with all of the sort-a critical components in the kit but the sort-a-not-a critical components that add bulk and weight to your shipping costs are left for you to obtain locally. Typically these parts are things that you will be able to find at any reasonably well stocked hardware or "hobby electronics shack" store. These locally obtained materials may need simple modifications like drilling, sawing, painting and other typical "home shop" operations.

The RST-8710 VHF Vertical Dipole antenna is one of these sorta-kits. All the electronic parts are included with the RST-8710 to make one antenna for any 15 MHz segment of the VHF COM aircraft band (118-137 MHz), or the amateur radio 2-meter (144-148 MHz) band.

The basic antenna is made of copper tape and coaxial cable (RST supplied) mounted on a wooden dowel and enclosed in a PVC water pipe enclosure (you obtain locally). After assembly in accordance with our instructions, the antenna is weather and water proof as well as structurally robust.

The RST-8710 antenna may be constructed for any center frequency from 125 MHz through 500 MHz using the materials supplied by a simple frequency scaling routine. The antenna length as well as number of choke coil turns is a linear function of frequency and may be scaled directly – the higher the frequency, the shorter the antenna and the less choke turns required.

For center frequencies below 125 MHz RST suggests that you construct the antenna using #14 copper wire ("Romex" house wire) with a small reduction in bandwidth and purchase a longer length of RG-174 coax cable from any good electronics supply house (Mouser, Digi-Key or Jameco).

B. WARRANTY

The Sorta-Kit warranty is the same as the regular kit warranty. We guarantee that the kit will meet the published specifications and that the components supplied and specified will meet those specifications including parts and labor for one year.

We guarantee the components for an additional year (without labor) if the defective component is returned to RST Engineering postpaid. In general, for a Sorta-Kit we will ask that you phone us first and describe the nature of the failure. If we determine that the component is in fact defective by the phone call we will usually (but do not obligate ourselves to) send a replacement component without the expense of your having to return the defective part.

We think that it is obvious that any component that has been subjected to excessive strain not normal in the service contemplated is not covered by this warranty. In particular, overtemperature during soldering, improper mechanical assembly, and use of the product beyond the scope of the

instructions in this manual constitute abuse of the product and voids the warranty. No other warranty is expressed or implied, including warranty of merchantability or fitness of purpose.

C. TEST AND CALIBRATION

The Vertical Dipole needs no calibration prior to use. To test the Vertical Dipole requires a source of RF energy (a transmitter) and a Standing Wave Bridge (VSWR Bridge or Bidirectional Wattmeter) connected as shown on drawing 871-3950 in section H of this manual. As shown in the VSWR curves in section H, the return loss should be below 1.5:1 (4% or 14 dB) at the frequency for which the dipole is cut and rise symmetrically on both sides. The VSWR test is optional, but it gives a confidence and correlation factor to the field test below.

If necessary, slight decreases in length (to raise the resonant frequency) or increases in length (to lower the resonant frequency) may be accomplished by cutting a short length equally from both dipole elements with a hobby knife or razor trimming blade. To lower the frequency, add short lengths of tape to the elements, cut the short length of tape twice as long as you think necessary, then overlap the tape elements with the tape sections and solder the junction of the short added tape piece with the tape element.

We **STRONGLY** recommend that a field test be performed on the antenna prior to final assembly. The very best test is to use a known good omnidirectional antenna on your transmitter and a known good receiver at some distance from the antenna. Make a test transmission and note the signal strength on the receiver. Replace the known good antenna with your newly constructed Vertical Dipole antenna and make a second transmission. The field strength on the receiver should be equal to or greater than the field strength with the known good antenna.

(Note: be sure that you only hold the Vertical Dipole in position for this test below the matching coil section. Holding the antenna near the elements, especially with metallic fasteners, will detune the elements and render this field test useless.)

D. THEORY OF OPERATION

The Vertical Dipole antenna is comprised of two major sections – the antenna elements and the coaxial matching coil.

The antenna elements are the classic dipole-in-space design with a rigid wooden rod supporting the elements as well as providing a coil form for the matching coil. Good dry varnished hardwood is an excellent low-loss insulating material as well as a mechanically rigid structural material.

The general problem with a vertical dipole is the proximity of the coaxial feedline cable to the bottom element of the dipole. By using a self-resonant coil at the base of the dipole, the coax cable can be isolated from the dipole elements.

This antenna may be constructed for "conformal" or "plastic airplane" use with the copper tape attached to a flat piece(s) of flexible plastic instead of a rigid hardwood dowel and the coil wound on any material (wood, plastic, etc.) of the proper $\frac{3}{8}$ " diameter. In this way, the antenna may be "bent" around other non-metallic structures to conform to the shape of the airframe.

At any rate, the self-resonant coil is the basis for the decoupling and matching of the coaxial cable to the antenna elements. Any coil is comprised of two parts – the inductance of the "wire" due to the number of turns of wire in the coil and the capacitance between each of the turns of wire in the coil. When the inductive reactance of the coil equals the capacitive reactance of the coil, the coil is said to be "self-resonant." This simply means that we have come to the frequency where the coil is parallel resonant with the inductance and the self-capacitance of the turns of the coil. Since a parallel resonant circuit provides a very high impedance, any energy contained on one side of the coil will not be coupled to the other side of the coil.

The coil "wire" is simply the outer shield ("braid") of the coaxial cable used as a feedline. We have chosen the number of turns of this coaxial cable to be self-resonant at the operating frequency of the antenna. The power is delivered to the antenna by the center conductor of the coax, which is isolated from the outer surface of the braid by the braid itself. Thus, the power is delivered to the antenna via the antenna center conductor, but any reradiation of the power down the outer shield or braid of the coax cable is prevented from going back to the transmitter by the self-resonant properties of the braid wound into a coil.

E. INSTALLATION

The base-station configuration of the RST-8710 antenna must be installed with any metallic clamping devices (hose clamps, metal wire clamps, conduit clamps, etc.) installed **BELOW** the matching coil area inside the PVC pipe. If you install the decal as shown in the construction section, then you have an easy reference to the location of the coil area inside the pipe.

Drawing 871-3951 (attached at the end of this manual) shows several ways to mount the antenna as a base station antenna.

- A. Drill a small pilot hole into the top PVC end cap and thread a metal eyelet into the end cap. Use some sort of sealant (RTV[®] or silicone sealant) on the threads to keep the inside of the pipe hermetically sealed. This method of mounting is used primarily in a portable/emergency environment where a string is looped around a tall tree branch and the antenna hauled up by the string. If you are in the field and need to make an emergency mount without the eyelet, simply use a tight knot on the pipe side of the top PVC end cap and haul the antenna up by the flange on the end cap.
- B. This method of mounting supposes that you are going to use metal clamps (radiator or worm clamps) to fasten the antenna to another mast. In this method of mounting, cut the long PVC pipe 2" shorter than the directions say, glue a $\frac{1}{2}$ " PVC slip coupling to the bottom of the mast, and then glue a $\frac{1}{2}$ " short PVC pipe section into the slip coupling. Install the bottom end cap in accordance with the standard directions.

C. This is similar to the "B" method of mounting, but instead of a slip coupling, a 1/2" PVC Tee fitting is glued onto the long pipe, then the short pipe glued into the Tee. A short (3/4" or so) pipe section couples the Tee to a slip-threaded Ell. This method is used where you have a 1/2" pipe thread already on your antenna mast and you wish to make the mounting onto this pipe thread. (**NOTE:** the antenna is no longer hermetically sealed with this option of mounting.)

Installation of this antenna into a composite structure (i.e., a "plastic airplane") may be done by any one of a number of methods. Certainly the rigid wooden dowel may be used if you wish, but it is also possible to install the tape onto a thin piece of flexible plastic or fiberglass, or onto the aircraft structure directly, if you choose. The only warning that RST can give is that the matching coil be wound on the proper diameter form AND that it be wound at a distance from the center of the dipole as measured and shown in the construction plans. The distance between the coax cable and the bottom of the antenna is NOT critical, so long as you understand that the braid of the coax is soldered to the **BOTTOM** element of the dipole at the dipole center.

In both the base station configuration AND the composite configuration, it is **ABSOLUTELY** necessary to use 50 Ω coaxial cable between the antenna and the transmitter. Using "cable TV" coax (70 Ω) will NOT make the antenna perform as designed.

F. OPERATION

There are no controls or other adjustments on the RST-8710 antenna. After the antenna has gone through installation and test, it should require no adjustment throughout its lifetime.

G. CONSTRUCTION

The construction steps below are geared towards the construction of a base station version of this antenna. If you are going to use the antenna in a composite structure ("plastic airplane, etc.) then you may follow the general ideas below, substituting your own personal materials and methods for the specific steps that follow.

1. Items Required But Not Supplied

- a. Wooden dowel material, hardwood $3/8$ " diameter. Length as determined by formula. (Note: Hardware stores generally do not stock $3/8$ " dowel material longer than 48" long.)
Alternatively, use plastic pipe or rigid plastic tubing $3/8$ " diameter which comes in lengths longer than 48", but is not as readily available.

- b. PVC plastic pipe, schedule 40 (white), 1/2" size. Length 4" longer than the dowel.
- c. PVC plastic end caps, schedule 40 (white), 1/2" size (quantity 2).
- d. Shop materials: Drill, 1/8" bit, 3/8" bit, saw, soldering iron & solder, pipe glue.

2. Assembly

For your own reference in the following steps, you may wish to fill out this table of dimensions calculated from drawing 871-2950 in Section H of this manual. Alternately, the Excel spreadsheet supplied with this manual will do these calculations for you:

Dimension	Reference	Value
Center Frequency (MHz)	F	
Tape Length	TL	
Hole Length	HL	
Antenna Length	AL	
Coil Length	CL	
Number of Turns	#	
Dowel Length	DL	

- a. Cut two identical pieces of tape to the length for your chosen frequency as shown in drawing 871-2950 in Section H of this manual (dimension TL).

Note that the creases in the tape at the folds may be taken out with a blunt instrument (like the handle of a hobby knife or a fingernail) and a hard surface (like a kitchen counter). Gently burnish the tape creases out with the blunt instrument and with the tape resting on the hard surface. If you choose not to burnish the creases out, it will NOT affect the performance of the antenna. You may also burnish out the creases on the hardwood dowel after you install the tape onto the dowel.

- b. Cut the wooden dowel to length as shown on drawing 871-2950 (dimension DL). Drill the three $\frac{1}{8}$ " holes in the dowel as shown. Varnish or use sanding sealer to seal the wood surface. (We use Deft® interior finish sealer at RST.)
- c. Cut the PVC pipe to 4" longer than the dowel length (DL) as cut in step b. (See mounting instructions in "Installation" before cutting pipe.)
- d. Drill a hole in one of the plastic end caps $\frac{3}{8}$ " diameter in the center as shown on drawing 871-2950 in section H of this manual. (Note – for better sealing, you may wish to countersink the outside of the end cap so that the BNC connector fits down into the countersink. Countersinking the outside of the end cap also makes it a little easier to start the nut onto the BNC connector threads in a later step.)
- e. Remove the covering from the self-sticky back of the tape. Install the tape onto the dowel as shown on drawing 871-2950. Be sure to leave a $\frac{1}{4}$ " gap between the two elements and the two elements equidistant from the $\frac{1}{8}$ " hole at dimension HL. Cut the V-notch into the tape near hole HL as shown in photo 5.a.
- f. Insert one end of the RG-174 coaxial cable through the hole at dimension HL so that the coax cable protrudes through the copper tape side of the hole about a foot. Strip the end of the coax protruding through the hole in the following manner:
 - 1) Remove $\frac{1}{2}$ " of the black outer sheath. Try to cut or nick the braid as little as possible when removing the plastic outer sheath.
 - 2) At the base of the exposed braid, where the braid exits the stripped sheath, move the braid with an icepick or other sharp pointed instrument so that it forms a hole in the braid big enough to pull the center insulator through
 - 3) Pull the center insulator through this hole at the base of the braid so that you have $\frac{1}{2}$ " of braid with nothing in the center and $\frac{1}{2}$ " of center insulator with center conductor inside.
 - 4) Strip the center insulator back $\frac{1}{4}$ " so that there is $\frac{1}{4}$ " of bare center conductor exposed.

- 5) Pull the coax back down into the hole so that only the braid and center conductor still protrude through the hole. Connect the coaxial cable by soldering the coax cable to the copper tape antenna elements as shown on drawing 871-2951.
 - 6) Be sure that the center conductor of the coax is soldered to the TOP element, and the braid is soldered to the BOTTOM element.
 - 7) Be very careful when soldering the coax to the copper tape that you do not overheat the coax and melt the center insulation. You may wish to use an ohmmeter to check that there is an open circuit between the antenna elements after you complete the soldering procedure.
-
- g. Route the coax straight down the wooden dowel on the side of the dowel opposite that of the copper tape and pass the free end of the coax through the top remaining hole in the dowel (dimension AL). Using the number of turns of coax calculated in drawing 8710-2950, wind the correct number of turns of coax onto the dowel. Wind the turns as close together as possible. Pass the free end of the coax cable through the bottom hole (dimension CL). (If you didn't wind the coax coil turns very close together, this will be a very tight fit.)
 - h. Twist the coax-coil turns so that the coax is wound tightly around the dowel. Take any slack in the coil up by pulling the excess coax through the bottom hole in the dowel.
 - i. Cut the free end of the coaxial cable so that there is 6" of cable remaining below the bottom of the dowel. Strip the outer black sheath from the end of the coax so that there is 1" of braid exposed. Make a hole in the braid and pull the center insulator and conductor through this hole in the braid in a similar manner as step f above.
 - j. Strip the insulation from the center conductor so that there is about ¼" of center conductor exposed.
 - k. Install the BNC female chassis mount connector through the drilled hole in the end cap so that the body of the connector is on the OUTside of the cap. Install a solder lug under the nut securing the connector to the cap. Bend the solder lug up away from the plastic body of the end cap as much as possible. Note – if you want this antenna hermetically sealed, use a little silicone sealant on the outside surface of the pipe cap when installing the connector.

- l. Solder the center conductor of the coax cable coming from the bottom of the pipe to the center pin of the BNC coax connector. Solder the braid of the coax to the solder lug of the BNC connector. Make this last connection with a hot iron and as fast as possible to avoid melting the plastic pipe cap body.
- m. This is the last opportunity you will have to test your antenna before it is sealed. Please perform any testing and last-minute adjustments you want to make at this time.
- n. Carefully push the dowel-antenna into the pipe from the bottom as far as possible without stressing the coax cable - connector joint. The top of the dowel should be $\frac{1}{2}$ " above the top of the pipe.
- o. Install the $\frac{3}{8}$ " vinyl grommet over the top of the dowel so that the top of the grommet and the top of the dowel are flush with one another. Using a small screwdriver or other small flat tool, work the grommet-dowel assembly back down into the pipe so that the tops of the dowel, grommet and pipe are all the same. Note – the grommet was deliberately chosen slightly oversize to make a tight "squeeze" fit for vibration resistance.
- p. Place the "Use Clamps Below This Point" decal to the pipe so that the line on the decal is aligned with the bottom of the coil inside the pipe. Place the other two decals on the pipe, one at the midpoint and the other 1" below the top of the pipe. If desired, you may coat the decals with a thin coat of varnish or sealer to keep weather from harming the decals.
- q. Use PVC cement to attach the top and the bottom pipe caps to the pipe. When installing the bottom cap, get as much of the coax into the bottom of the pipe as possible before applying the cement.
- r. This completes the construction of your antenna.

H. DRAWINGS, PARTS LISTS AND APPLICATION NOTES

1. Parts List

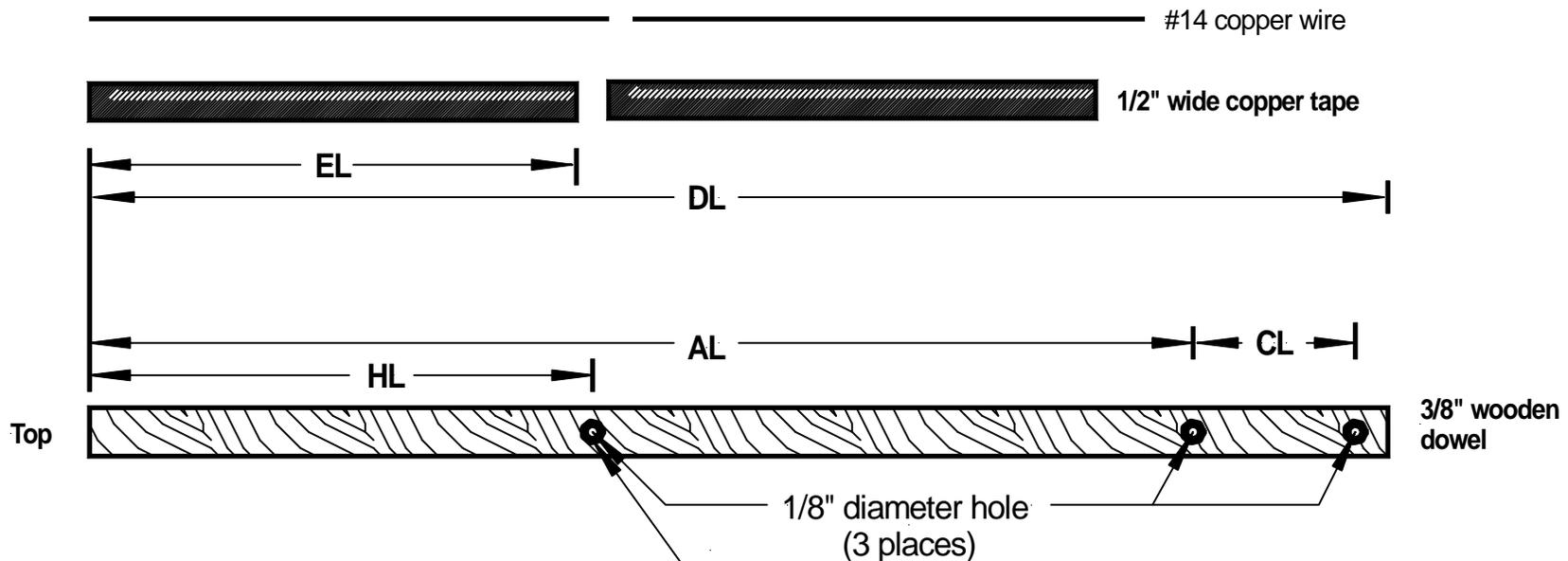
Master Parts List		RST-8710 Vertical Dipole	9-8710-0902
Qty.	Part Number	Part Name	Part Detail
1	1-1201-1507	Antenna tape, copper	1/2" x 0.001" x 48"
1	1-2120-3001	Conn, bnc	female chassis, UG1094/U
1*	1-2501-1237	Lug, solder, flat	3/8"
96	1-6031-1740	Cable, coax	RG-174
1	2-4201-1037	Grommet	0.37"
1	4-0001-8000	Owner's Manual	CDROM Rev:B
1	4-8710-0100	RST-8710	Decal (3-across)

*This solder lug may be supplied with the BNC connector (1-2120-3001)
Lengths given in inches.

2. Manufacturing Dimensions (871-2950)

3. VSWR Curves and Test Setup (871-3950)

4. Mounting Methods (871-3951)



Lengths in inches calculated for an antenna at frequency "F" in MHz.

$$EL = 2690 / F \text{ (for copper tape)}$$

$$EL = 2745 / F \text{ (for #14 wire)}$$

$$HL = EL + 0.2"$$

$$AL = EL + HL + 0.1$$

$$CL = 550 / F$$

$$\text{Number of coil turns} = 4750 / F$$

$$DL = AL + CL$$

Sample calculation for a resonant frequency of 125.0 MHz.:

$$EL = 21.5"$$

$$CL = 4.4"$$

$$HL = 21.7"$$

$$\# \text{ of turns} = 38$$

$$AL = 43.3"$$

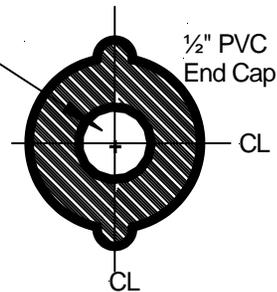
$$DL = 47.7"$$

3/8 diameter hole
in center of cap

1/2" PVC
End Cap



Cut notches in copper tape at
hole to provide clearance for
soldering coax cable wires.



RST 8710 Antenna Manufacturing Dimensions

Scale: NTS

Approved by:

Drawn by: OWJ

Date: 07 Jan '14

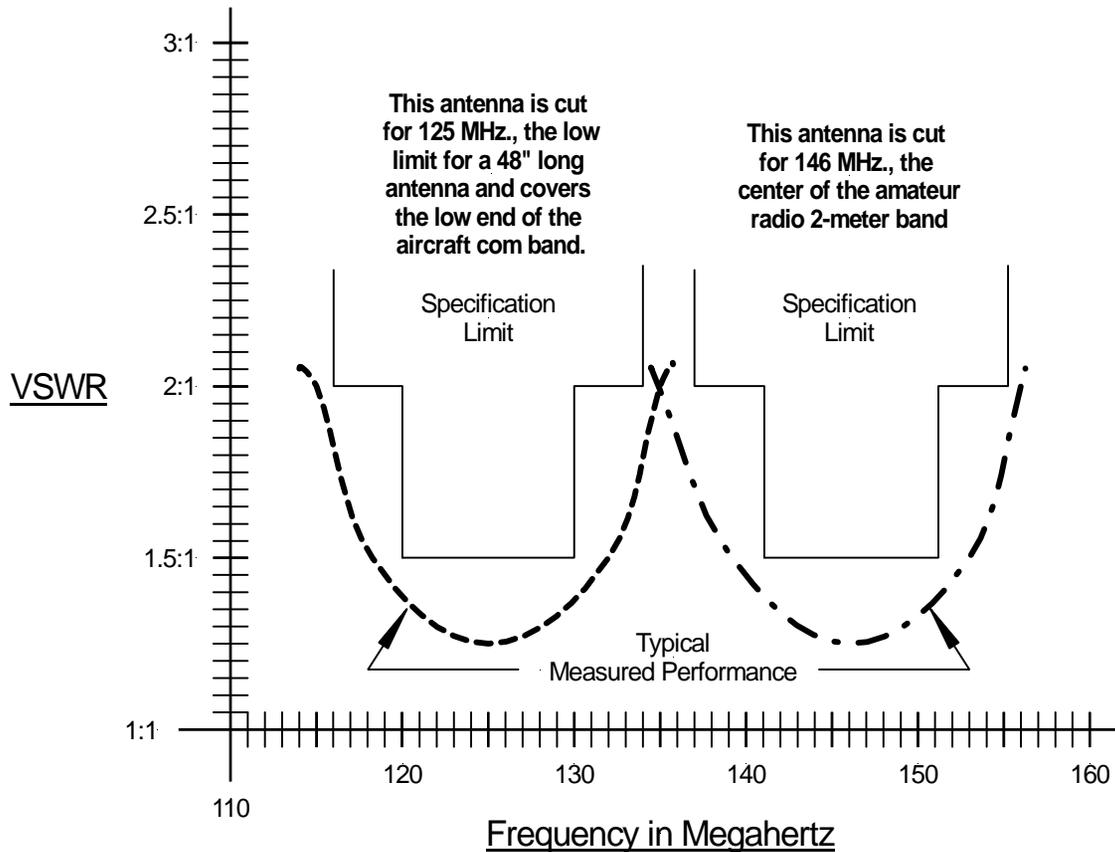
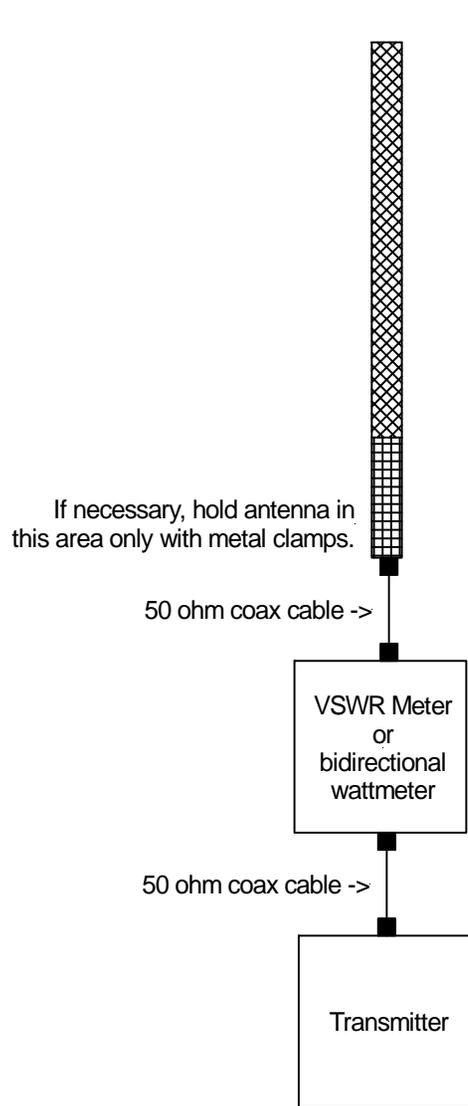


Rev: B

RST Engineering

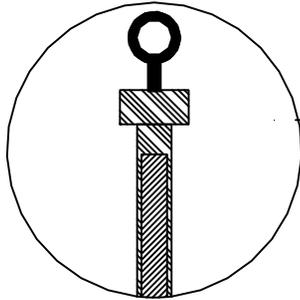
13993 Downwind Court Grass Valley CA 95945
530.272.2203 tech@rst-engr.com

Drawing #
8710-2950
sheet 1 of 1



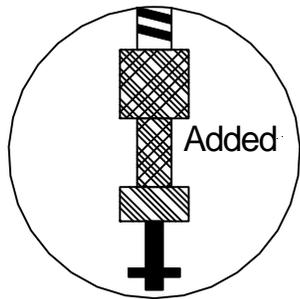
RST 8710 Antenna VSWR Curves & Test Setup		
Scale: NTS	Approved by:	Drawn by: OWJ
Date: 07 Jan '14		Rev: B
RST Engineering 13993 Downwind Court Grass Valley CA 95945 530.272.2203 tech@rst-engr.com		Drawing # 8710-3950 sheet 1 of 1

OPTION A
Add threaded
metal hook into
top PVC end
cap

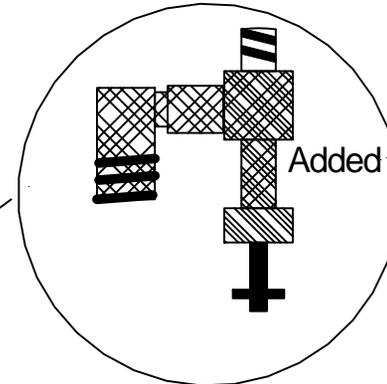


Basic "As Constructed"
Antenna

OPTION B
Add PVC slip
coupling and
extension pipe
below coil area



OPTION C
Add PVC TEE
and right angle
threaded adapter
below coil area



**RST 8710 Antenna
Optional Mounting Methods**

Scale: NTS

Approved by:

Drawn by: OWJ

Date: 07 Jan '14



Rev: B

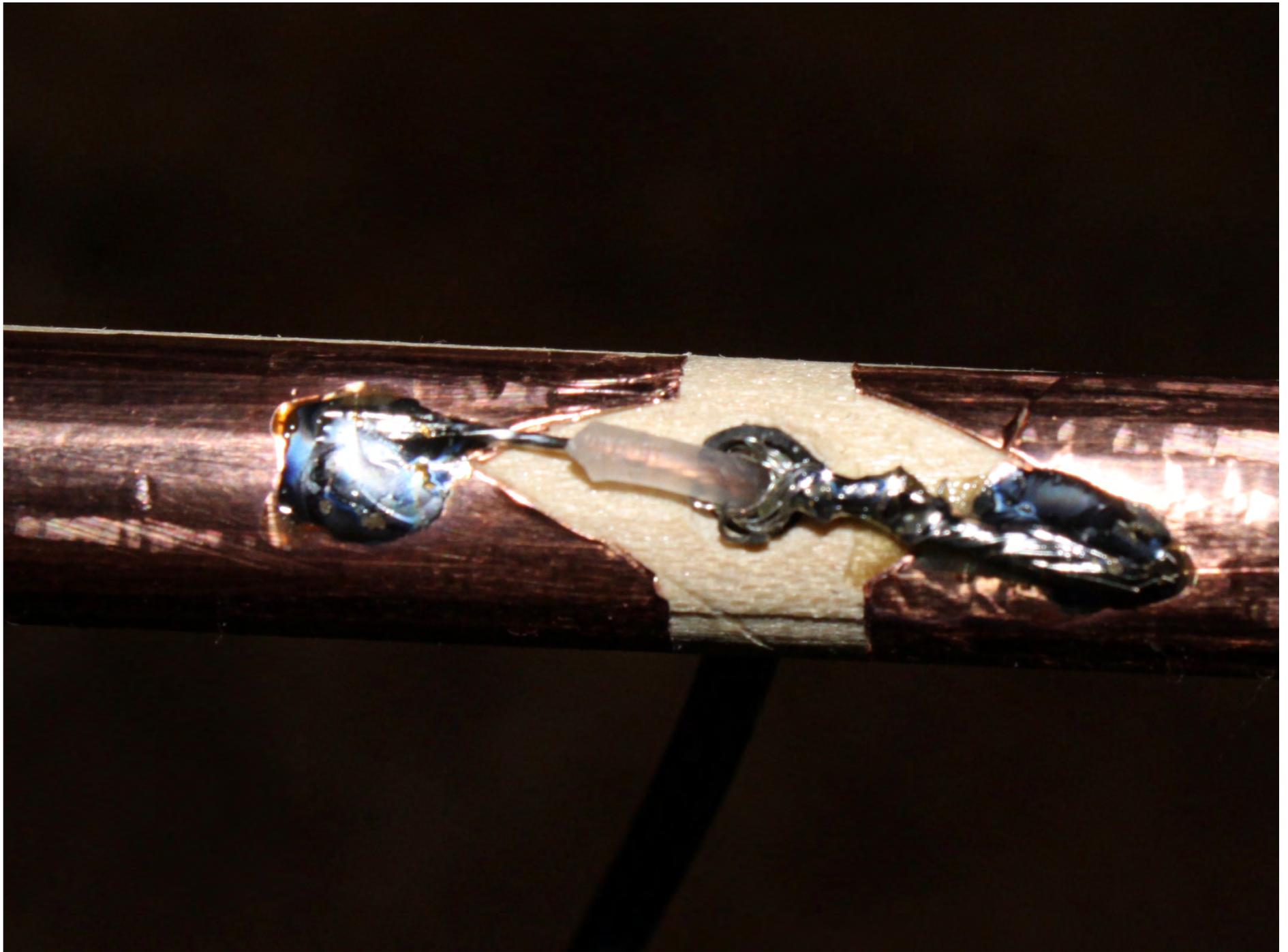
RST Engineering

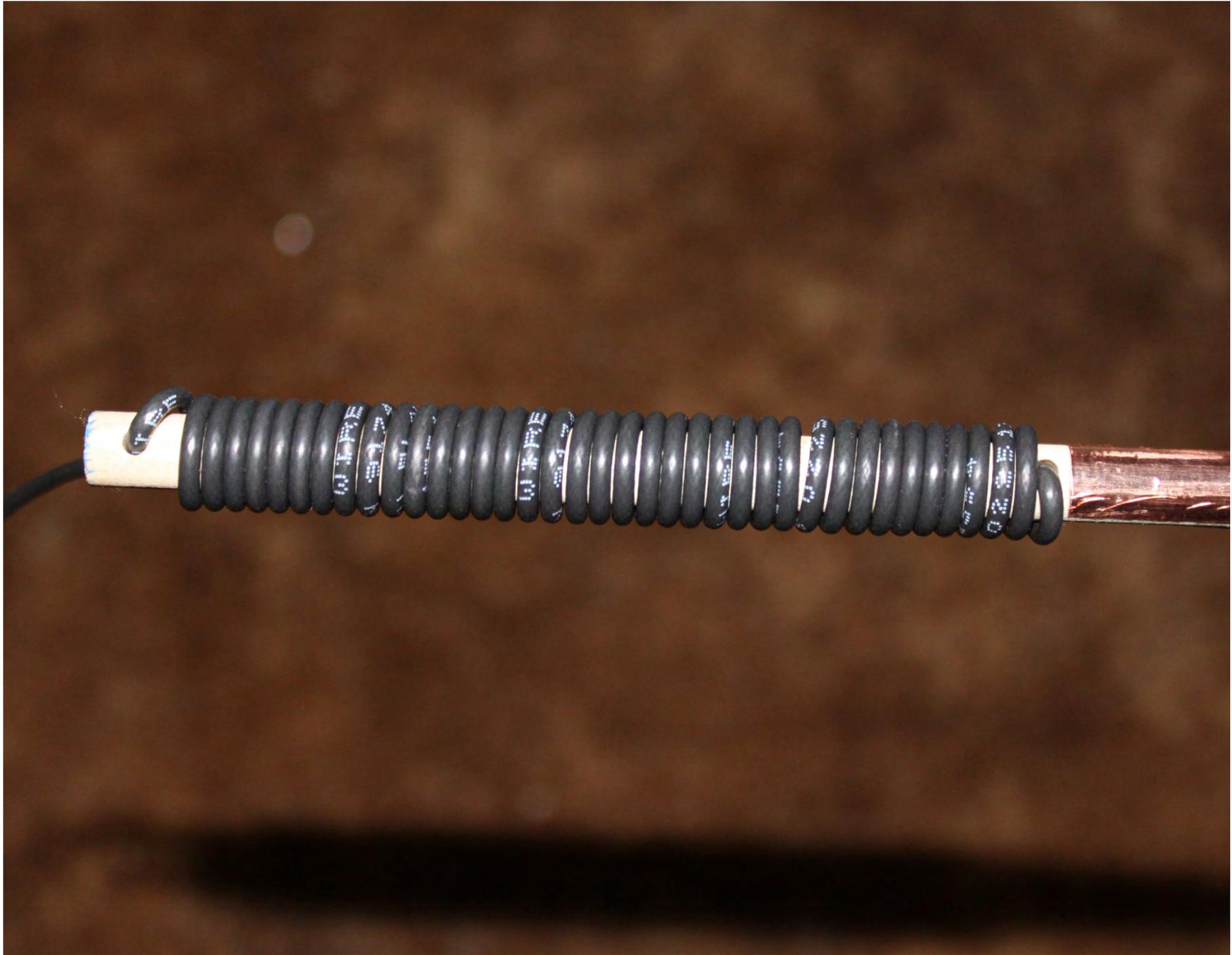
13993 Downwind Court Grass Valley CA 95945
530.272.2203 tech@rst-engr.com

Drawing #
8710-3951
sheet 1 of 1

5. Photo Identification

- a. Connecting the coax to the copper elements
- b. Construction of the coil
- c. Connecting the coax to the BNC connector
- d. Using RTV (silicone seal) to immobilize the solder connections
- e. The assembled antenna before putting it into the plastic pipe
- f. The completely assembled antenna (with Option C mounting method)
- g. Close-up of Option C mounting method















NOTES: