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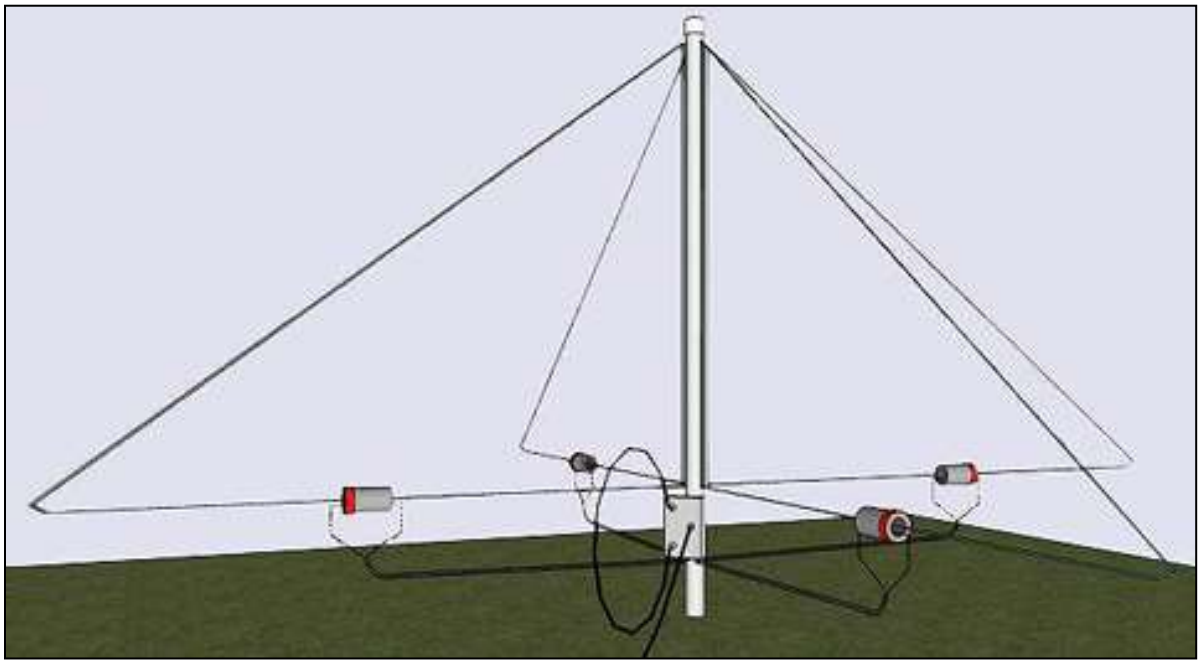
Model AS-SAL-12/20/30 — 8 Direction RX Loop System

Manufactured and marketed under United States Patent No. 8,350,776 and additional patent pending.



Introduction

The Array Solutions Shared Apex Loop™ Array (**AS-SAL-12**, **AS-SAL-20, and AS-SAL-30)** is a new type of receiving antenna that delivers exceptional directivity in a compact package and is useable over a wide range of frequencies without need for adjustment. This array opens the door to a new class of compact, high performance, wideband receiving antennas developed for both amateur and professional users.

In 2009, Mark Bauman (KB7GF) developed a working model of the array to improve his listening experience in a suburban neighborhood in southeast Washington State. From testing, he found that the array provided exceptional bandwidth in a compact size and provided good front-to-back and front-to-side ratio especially for local interfering signals.

The design of the array countered conventional wisdom by spacing a pair of loops only inches apart when state-of-the-art designs called for spacing on the order of ¼ wave length (over 100 feet on 160meters). Numeric modeling of the array showed that, for closely spaced loops, the spacing between the loops was much less important than the location of the feed point along the base of each loop. This provided the opportunity to simplify the installation because all of the loops could be held in place by a single non-conductive mast that acted as both a spacer and support.

In addition, inserting ferrite beads along the base of the loop to form transformers provided a convenient method of signal coupling as well as a great way to test various coupler locations. Modeling also showed a correlation between the coupler location and the response pattern and backward elevation null angle which was also verified during testing.

Utilizing the inherent front-to-side rejection of magnetic loops made it possible to achieve both front-to-back and front-to-side rejection using signals from only two loops and a single delay line. This simplified the signal combining task, and made it possible to locate all the signal processing electronics at a single position at the base of the array.

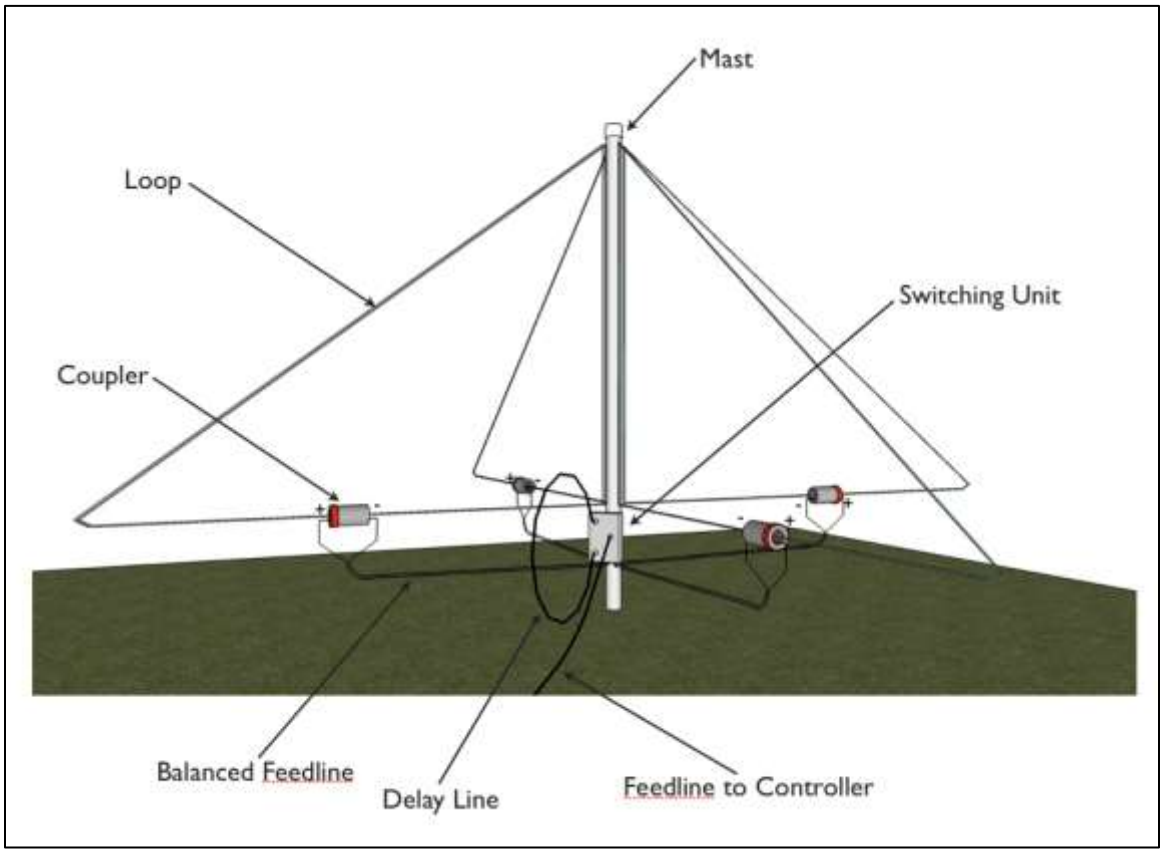
Next, testing commenced on two orthogonal pairs of loops and switching circuits were developed to provide electronic rotation of the pattern. This testing showed that eight individual directions could be obtained using the four loops. These switching circuits included a multiplexing scheme where the switching commands and power were sent on the same feed line that returns the signals from the array. This technique greatly simplifies the installation.

Challenges remained, however before a commercial array could be made available. Designing the amplifier chain was especially difficult because of competing constraints. These included the need for closely matched input impedance over a wide frequency range (to ensure accurate timing), very low noise (because of negative forward gain), good gain (to overcome signal cancelation), and acceptable linearity. Finally, though, after a period of extensive testing and improvement, the Shared Apex Loop™ array is ready for production.

Description

In principle, the array provides directivity by summing signals from one loop with delayed signals from an oppositely phased and positioned loop. Both the delay and loop phasing are largely frequency independent providing a directive pattern over a wide frequency range.

The array consists of four identical right triangle shaped wire loops whose vertical sides are each separated and supported by a single non-conductive mast. The loops are arranged around the mast so that one loop points towards the northeast, another to the southeast, another to southwest, and another to the northwest.



The direction and directional mode of the array is commanded by a controller that connects directly to your receiver. The controller has buttons for changing the direction, flipping to the opposite direction, and selecting the directional mode. The directional modes include a Single or UNI-directional mode as well as a dual or BI-directional mode. Visual indicators show the currently selected direction and directional mode. A remote interface is included that enables the controller to be commanded by a computer.

A single RG-6 coaxial feed line connects the controller to the array to power and command the array as well as transport the received signals from the array to the controller.

Ferrite couplers are located along the base of each loop at a specific distance from the mast and connected to balanced feed lines that bring the signals to a switching unit mounted on the mast. Relays in the switching unit route signals from the appropriate

combination of loops in response to commands received from the controller. A single delay line also connects to the switching unit to provide the necessary true-time-delay so that signals can be properly combined to achieve the desired directive pattern. The switching unit has a socketed dual stage preamplifier that provides a buffered and matched load for the combiner and boosts the summed signals before they are sent to the controller.

The **AS-SAL-12** should provide a directional pattern up to 25 MHz. The **AS-SAL-20** should provide a directional pattern up to 14 MHz, and the **AS-SAL-30** up to 7 MHz.

The Shared Apex Loop™ design provides the following benefits:

- Competitive Front to Back/Side rejection in eight directions especially on low angle vertically polarized signals and local interference
- Compact footprint that is ideal for small yards
- Easy setup for tactical applications
- Wideband operation without need for adjustment that is great for SDR, Skimmers and military
- Ease of Construction, and quick deployment, DX-peditions, military, seasonal take down is easy
- No RF ground at the antenna required
- Modular design – easy to replace parts
- Field upgradeable - amplifier stage is socketed
- No control cables; control and powered over the RG-6 coax feed line from the controller, very smart and cost effective design.
- Controller can be interfaced to a PC for remote operation

The **AS-SAL-XX Antennas contain the following parts**:

PACKAGE CONTENTS

SAL-30 Antenna Material List	
QTY	**ITEM**
9	1-3/4" fiberglass pipes
4	95 ft (28.95 m) cables for loops
8	Anchoring Stakes
40	ft of rope (cut to 4 x 10 ft (3.05 m))*
240	ft of rope to cut as follows: *
	4 x 28 ft (8.53 m) guying ropes for inner stakes
	4 x 32 ft (9.75 m) guying ropes for inner stakes
1	Mast base
12	Guy rope tensioners
6	Guy rope rings (5 std. + 1 thicker for the top)
4	Couplers with 17 ft (5.18 m) TP TX lines
1	21.5 ft (6.55 m) RG-6 coaxial delay line
1	Control Switch
1	Combiner/Pre-amp
1	Power supply

* Suggested cutting lengths may vary depending on site's topography.

SAL-20 Antenna Material List	
QTY	**ITEM**
6	1-3/4" fiberglass pipes
4	62ft (18.9 m) cables for loops
4	Anchoring Stakes
40	ft (12.19 m) of rope (cut to 4 x 10 ft (3.05 m))*
4	Guy rope tensioners
4	Couplers with 10 ft (3.05 m) 120 ohm TX lines
1	Mast base
3	Guy rope rings
1	11 ft (3.35 m) of RG-6 coaxial delay line
1	Control Switch
1	Combiner/Pre-amp
1	Power supply

* Suggested cutting lengths may vary depending on site's topography.

SAL-12 Antenna Material List	
QTY	**ITEM**
4	1-3/4" fiberglass pipes
4	38 ft (11.6 m)cables for loops
4	Anchoring Stakes
40	ft (12.2 m)of rope (cut to 4 x 10 ft (3.05 m)) *
4	Guy rope tensioners
4	Couplers with 6 ft (1.83 m) 120 ohm TX lines
1	Mast base
3	Guy rope rings
1	7 ft (2.13 m) of RG-6 coaxial delay line
1	Control Switch
1	Combiner/Pre-amp
1	Power supply

* Suggested cutting lengths may vary depending on site's topography.

INSTALLATION

** WARNING! INSTALLATION OF ANY ANTENNA NEAR POWER LINES IS DANGEROUS **

Warning: Do not locate the antenna near overhead power lines or other electrical circuits where the antenna could come in contact with these circuits. When installing the antenna, take extreme care not to contact electrical power lines or circuits, because they may cause serious injury or death!

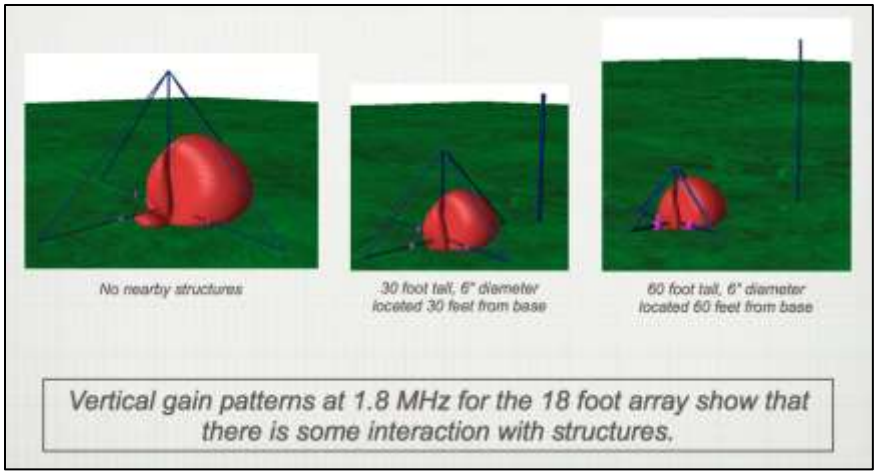
IMPORTANT NOTE: If you are installing the SAL-30 or upgrading to SAL-30, please read the Appendix 1 at the end of this manual regarding the SAL-30 erection. Otherwise, mast damage and personal injuries may happen.

Site Selection

The Shared Apex Loop™ array works by summing signals from oppositely positioned and phased loops. For proper operation, it is essential that each loop in each loop pair have identical signal response. Factors that can impact the signal response include:

- Size of the Loop
- Shape of the Loop
- Orientation of the Loop
- Distance of the Loop to the Ground
- Distance from the Loop to other metal objects

The ideal location for the array is on flat ground, away from any other objects. From our testing so far, we are finding that the Shared Apex Loop™ array is somewhat tolerant to the presence of both metal and non-metal objects positioned near the loops. However, numeric modeling shows that there are limits to this tolerance.



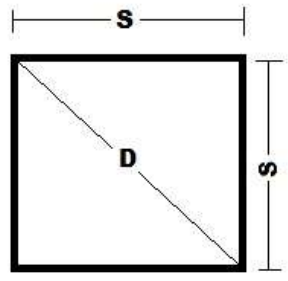
Based on this, here are some things to keep in mind:

- If the ground is uneven, try to mount the base of the loop at least 5 feet above the ground. You will need additional mast pipe to accomplish this.
- Keep antenna away from large metallic structures like towers, and your transmit antennas. We recommend at least 1/4 Wavelength distance at the lowest frequency of use.

As an example of an AS-SAL-12 that has good directivity from 300 KHz to 28 MHz, it is located with the edge of the array located 50 feet from a house, 90 feet from overhead power lines, 30 feet from ground mounted 36 foot vertical with ground radials close to the edge of the array, 10 feet from metal clothesline, and has an 8 foot tall bush growing near the center.

Required Area

SAL-30 approx a clear flat 50 feet(15.24 m) square
SAL-20 approx a clear flat 36 feet (10.97 m) square
SAL-12 approx a clear flat 26 feet (7.92 m) square
NOTE: If insulated posts are used to anchor the outer corners of the loop, the footprint can be reduced notoriously. See table and drawing below for comparison.



SAL Antennas Footprint with and without outer stakes

Model	With Stakes		With posts under outer corners		Unit
Dimension	S	D	S	D	
SAL-30	46.67	66.00	35.40	50.00	ft
	14.23	*20.12*	*10.79*	*15.24*	*m*
SAL-20	36.10	51.00	24.75	35.00	ft
	11.00	*15.54*	*7.54*	*10.67*	*m*
SAL-12	26.00	37.00	14.85	21.00	ft
	7.92	*11.28*	*4.53*	*6.40*	*m*

Pictures of Mast and Loop components

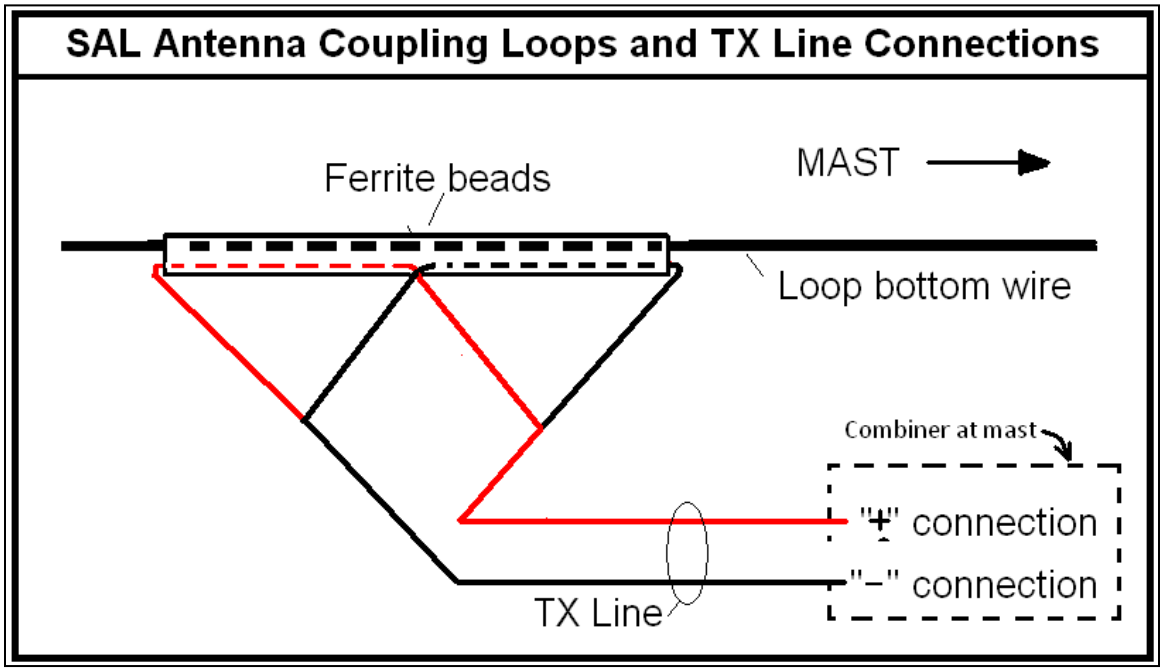
Mast fits on top of base, guy rings go above the first section, at intermediate sections, and at the top section. Lay the mast on the ground and string the 4 loop wires in the 4 corner holes of the guy brackets.

Mast shown on ground with guy brackets Attached, and on the right shows routing the coupler wires into the bottom of the box.

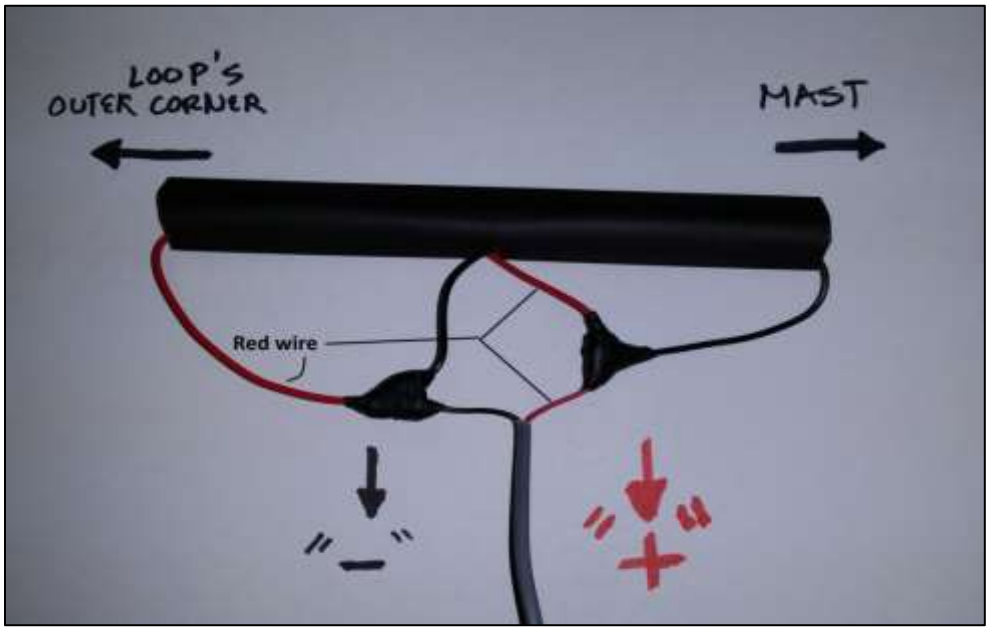
Detail to show how wires are routed through the guy rings, note that the delay line is mounted on the two bottom side by side connectors, and the controller feed line is at the top connector. Tie wraps hold the box to the mast.

Old coupler detail: Left side is towards outside of loop, right side is towards the mast. The colors of the wires may vary but will be the same for each loop array. Make the loops match. **The outer wire color indicates which is the positive ("+") connection at**

the combiner. In the picture above and the diagram below, the red wire is the positive. See next diagram for loop orientation and connections to combiner box.



The wires used may be different colors just make the orientation of each set of balanced transmission lines to be the same for each of the 4 loops. The polarity of the loop couplers should be symmetrically oriented on all 4 loops.
NOTE: If this is the black and white printout of the manual sent along with the antenna, please refer to the manual with color pictures and drawings available on our webpage for clarity.



New coupler. Detail of its connections. For B&W printouts, note the wires marked “red”. The other wires are black. Positive sign, “+” is red.

Coupler's transmission line is kept clear of ground and other loop transmission lines

View of the SAL-30 antenna. The loops' wires have been edited thicker for clarity. The thin lines are the guying ropes.

**** WARNING! INSTALLATION OF ANY ANTENNA NEAR POWER LINES IS DANGEROUS! ****

Installation Instructions

- **Site Preparation**
  - Prepare the location that the mast will mount. This may include installing a sleeve in the ground to receive the mast, preparing a hole, or pouring a concrete, etc. Do not yet raise the mast as you will need access to the top of the mast.
  - Select the location for the mast. Then, measure (33 feet for the SAL-30, 25.5 feet for the SAL-20 and 18.5 feet for the SAL-12) in a northeast direction and drive a loop stakes into the ground. Repeat this for the southeast, southwest, and northwest directions, stakes. Verify that each stake is in line with the center and its opposite stake. Note: These measurements are for ground mounted installations. For raised installations, the stake distance will need to be adjusted to properly tension the loops.

- **Loop installation**
  - Verify that all of the loop wires are the same length.
  - **Mark the wires ends with color tape, numbers, or any other way to keep track of which ends belong to the same wire.**
  - Build the mast on the ground and install the guy rope/wire rings at the 1 section above ground, 2 sections above that, and continue up using the guy rings, and finally **use the thick guy ring at the top of the mast (this applies for the SAL-30 only)**. You will run the loop wires in the 4 corner holes to keep them in line. And you can also use these rings to hold the guy ropes to keep the mast vertical. Guy ropes are supplied in the case of the SAL-30 you have the wires hold the top of the mast as guys. Please refer to the drawing on page 19 for guy ring positioning for SAL-30. Finally at the base of the mast the wire loops will act as the lowest set of guys.
  - The loops should have a right angle triangle shape to it when finished. The lower horizontal will have to have the loop couplers slid onto it. Lay it out on the ground and make sure you join the two ends of the loop wire on the **hypotenuse of the triangle or on the bottom wire far from the recommended coupler position, preferably close to the mast.**
  - Now, take any of the loops' #14 wire and thread it through one of the couplers' ferrite tube. The **polarity should be the same on all the couplers. All must be oriented so that the red wire or "+", or positive, that enters into the ferrites tube by one of its ends faces away from the mast on all of the couplers. This red wire should be connected to the corresponding "+" terminal in the combiner box. The black wire is the "-" or negative, is the one entering by the end of the ferrite tube that should be closest to the mast and connected to the corresponding "-" terminal.** *(Please refer to either the drawing or the picture on page 10)***.** Then, solder together the ends of the #14 wire to form a complete closed loop. Wrap these ends together with pliers so they are

mechanically secure and solder them. Try to position this splice close to the mast so it doesn't interfere with the coupler movement when optimizing the antenna.

- Make sure that the loop is not tangled with any of the other loop wires. Next, repeat these steps for the remaining three loops.
- Next, prepare the four tether ropes, each being about 10 feet long. Form a loose fitting knot around each of the four loops near the outer corner of each loop. A bowline works well. Also string on a rope tension device on each rope. You string them by pulling on the device, while feeding in the rope. The tensioner will then hook onto the ground stake making it easy to tension the antenna. There are two types of tensioners. Below is one type. The other type is a triangle tensioner.

Picture of the rope end of loop and tensioner with rope. The tensioner shown above works by pulling the inner lip cylinder out. It is spring loaded and will allow the ball bearings inside to separate so rope can be pushed through it. If the rope is too thick to go through use a piece of tape on the end as shown to thread the hole inside so the rope can be pulled through.

Triangle Tensioner: The one shown in the picture, when rotated counter clock wise will straighten the long side allowing the adjusting of the guy rope tension.

Mast installation

- Next, raise the mast with the attached loops, gathering appropriate help if needed to hold the mast in place while the loops are being anchored to the stakes which you drive into the ground with a hammer. Loop the tensioner bail over the stake and adjust tension on the tether rope. Tie off any excess rope around stake so the tensioner will not accidentally slip off in high winds.

- Then, adjust the mast and the tethers so that the mast is vertical and that the loops have the same size and shape.
- **The Horizontal part of each loop must be completely HORIZONTAL and not sloping away or towards the flat ground.**
- Measure and adjust the distance from the mast to the tether point so that this distance is the same for all of the loops. Also, adjust the tension on the tethers so that each loop has minimal amount of sag in the middle.
- Verify again that the mast is vertical. Repeat previous step until all loops are the same size and shape, **and horizontal parts are horizontal to the ground.**
- If the ground where the antenna is not flat and even, and there is the need to elevate the outer corners, make the slope and length of the lower wire equal for all four loops. The couplers may need to be positioned closer to the mast, therefore start at the recommended distance for the horizontal case and try to optimize the F/B of the antenna moving the couplers towards the mast.
- The horizontal length, mostly on the largest model, the SAL-30, **is about 25+ ft, not an exact dimension that depends on the wire sag and tension applied to it. Just pull the wire and adjust the length while keeping it horizontal until a reasonable tension is applied to the diagonal wire going to the top of the mast.**
- *Failure to make the loops closely the same size and shape will result in less than optimal results, especially below 4 MHz!*

- **Switching unit (combiner) installation**
  - Remove the cover of the switching unit so that the loop terminals are exposed. See picture on next page.
  - Route the northeast loop balanced line through one of the holes in the bottom of the switching unit. Connect the blue (+) wire to the NE+ terminal and the - wire to the NE - terminal.
  - Route the southwest loop balanced line through one of the holes in the bottom of the switching unit. Connect the blue (+) wire to the SW+ terminal and the - wire to the SW- terminal.
  - Route the southeast loop balanced line through one of the holes in the bottom of the switching unit. Connect the blue (+) wire to the SE+ terminal and the - wire to the SE- terminal.
  - Route the northwest loop balanced line through the remaining hole in the bottom of the switching unit. Connect the blue (+) wire to the NW+ terminal and the - wire to the NW- terminal.
  - Verify that the balanced lines are connected to the appropriate terminals. You should see a repeating pattern of wire colors (i.e. blue-WHITE-blue-WHITE-blue-WHITE-blue-WHITE).
  - *Note: The array will NOT be directive if the balanced lines are not connected in the proper order!*
  - Reinstall the cover onto the switching unit.
  - Mount the switching unit to the mast with a couple of tie wraps, the bottom guy bracket makes a nice place for the top tie-wrap. See picture.
  - Connect the ends of the RG-6 delay line to the two **side by side** F-Type connectors on the front of the switching unit (see picture below).
  - Connect the RG-6 feed line to the controller to the F-Type connector on the front of the switching unit. It is the connector on upper part of the box.
  - Is recommended the use of coax tape on the RG-6 connectors to protect them from the weather.

WARNING!
Do not insert any device in the RG-6 or the transmission line between the Combiner and the Controller of the SAL antenna. Most devices are a short circuit for DC and the command pulses and 15 V DC are sent to the combiner using the transmission. This can damage the device and the Combiner and Controller of the SAL antenna.


Feed Line
Delay Line
Delay Line


Shared Apex Combiner
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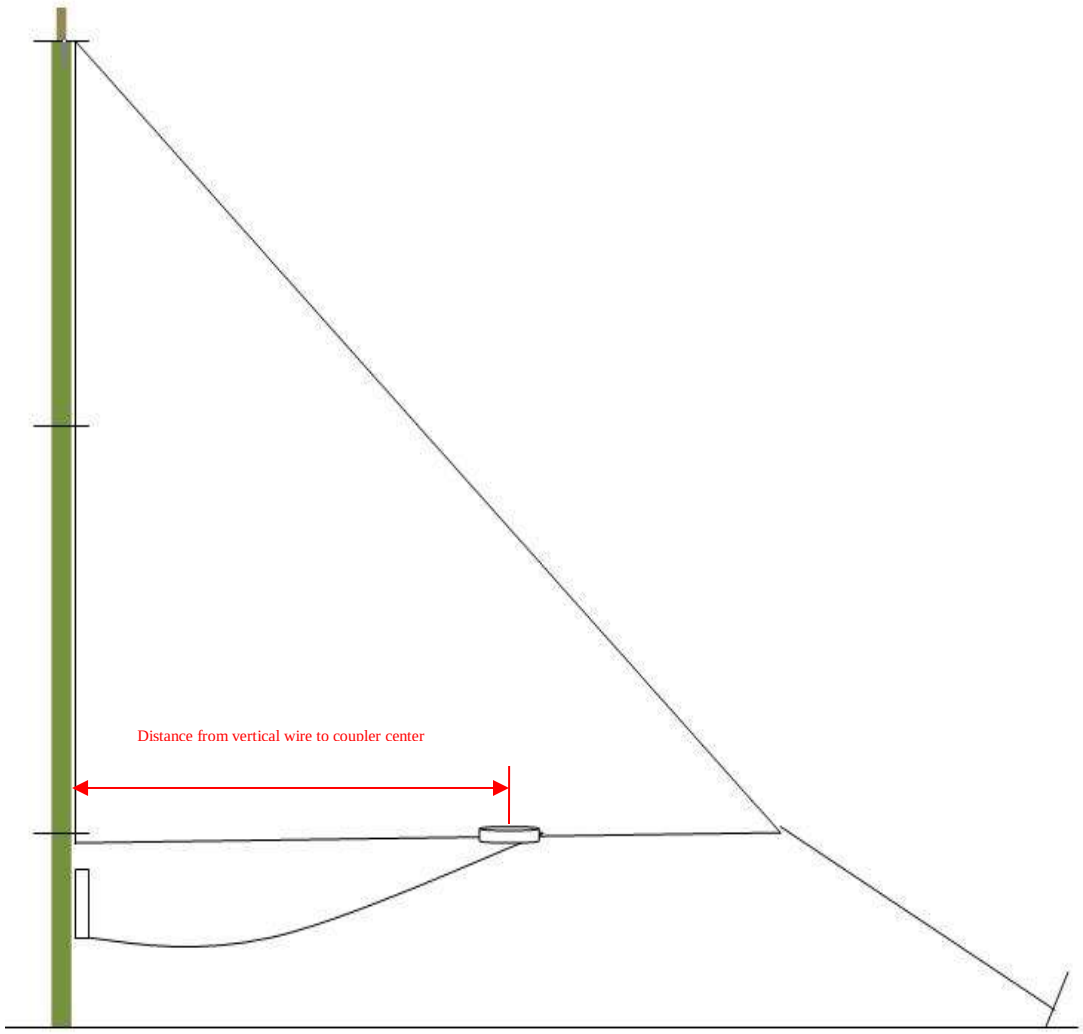
REV 2
-NW+ -SE+ -SW+ -NE+

- Coupler Positioning

- **For each loop, position each coupler per the diagram and table below.**
- Allow the balanced line from the coupler to freely drape from the coupler to the controller being careful that it does not touch the ground or wrap around the loop. Keep the line well away from the ground. You can use string or tie-wraps to suspend it up in the middle to the horizontal loop wire.
- *Note: The delay line length and coupler position largely set the directional pattern.* ***But you can adjust the null angle off the back by moving the couplers on the loop. One trick is to use a small RF source like an antenna analyzer perhaps located 500 feet away or even up your tower at an angle of say 15 degrees to the SAL Array. Then adjust the SAL for maximum F/B ratio by moving the couplers positions six inches at the time. When further optimization is needed move couplers in three inches steps. Each coupler must be moved the same amount towards or away from the mast. See the Optimization section of this manual. A reliable signal source like a broadcast station which its position relative to the SAL antenna is known can be used to optimize the front to back of the antenna. Keep in mind that at times near dusk and down the propagation will change and incoming wave angles will do as well and the front to back can vary a great amount while this propagation conditions are changing.***

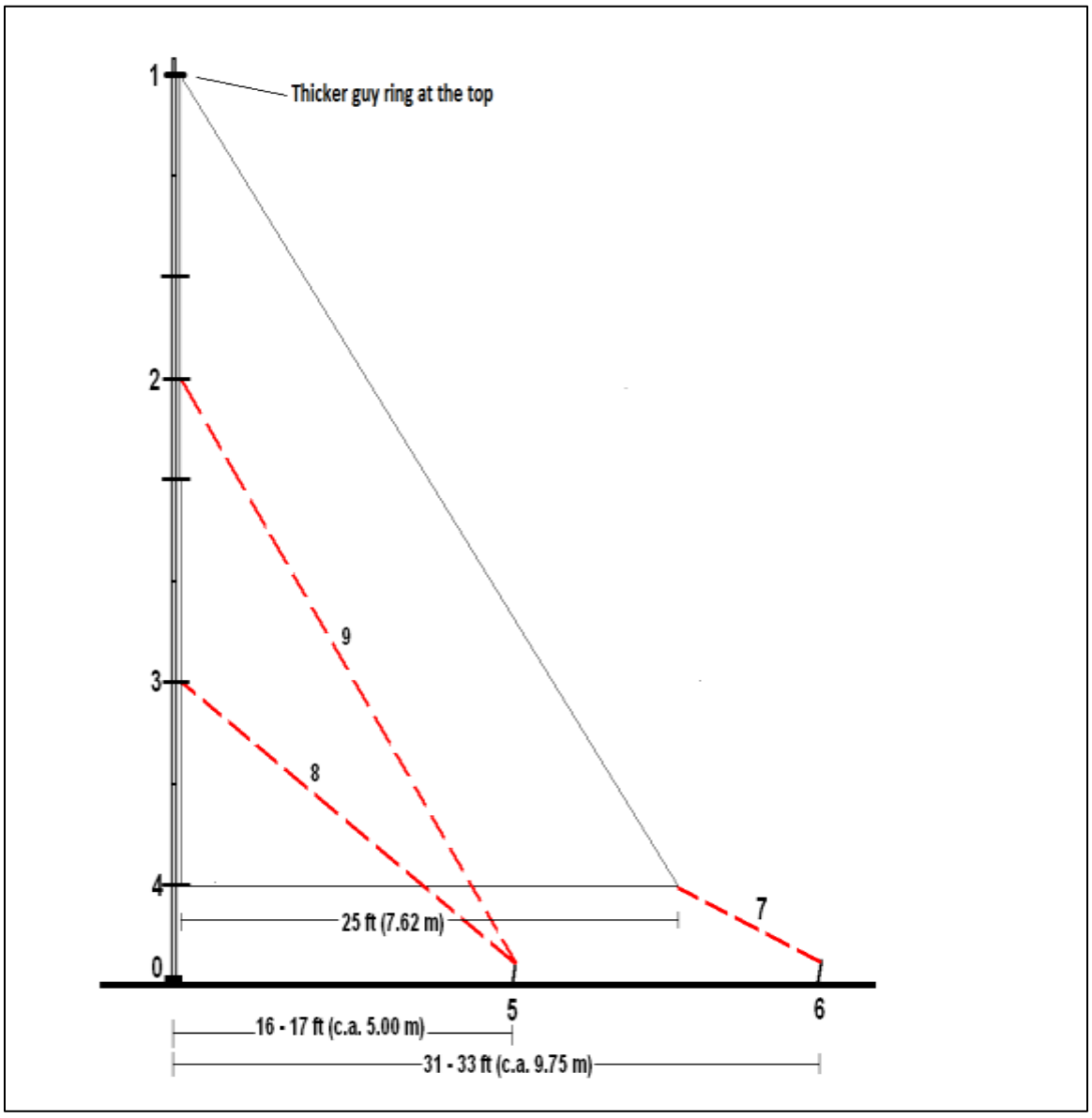


	SAL-30	SAL-20	SAL-12
Length of Vertical wire section	356" (904 cm)	222" (564cm)	136.5" (347cm)
Hor. section Length	300" (762 cm)	210" (534 cm)	126" (320 cm)
Total loop Length	1122" (2849 cm)	744" (1890cm)	456" (1158 cm)
Coupler Distance (From vertical wire of loop to center of coupler)	153" (388 cm)	86" (218cm)	60" (152cm)

NOTE: If you apply the Pythagoras formula to the triangles' dimensions shown above, keep in mind that the formula will work with straight lines drawn on a paper which does not include the wire sag and the lack of perfect straightness. What is important is that the loops have the same perimeter and are installed as symmetrically as possible within reasonable limits, regardless of their lengths as long as they are equal.

AS-SAL-30 guying diagram

One set of guys (9) has ropes that are approx 32 ft (9.75 m) long, a second set of guys (8) has ropes that are approximately 28 ft (8.53 m) and the outer set of guys (7) has 10 ft (3.05 m) ropes and is used to hold the loop out and tension the loop wires.



- Connecting the Controller

- Connect the RG-6 cable from the array to the back of the controller.
- Connect the receiver to the RCA connector at the back of the controller.
- Connect the power, it is a 2.1 mm DC coaxial jack connector. Array Solutions has included a 1 A – 12 to 15 V DC RF-quiet power supply.
- The NETWORK plugs are to daisy chain in and out the ShackLan ™ buss. This will allow controlling the array from a PC for remote operation. The Control Center software is a free application from Array Solutions.
- *Note: A good RF ground at the receiver is helpful to for optimum reception. You may also connect the chassis of the receiver to either the shield of the RCA connector or the RG-6 cable if this results in lower noise operation.*
- *NOTE: ENSURE THAT THE CONTROLLER IS ONLY CONNECTED TO A RECEIVER AND THAT NO TRANSMITTED RF CAN ENTER THROUGH THE RCA CONNECTOR. FAILURE TO DO THIS WILL RESULT TO DAMAGE OF THE CONTROLLER AND SWITCHING UNIT.*
- *NOTE: IT IS THE RESPONSIBILITY OF THE USER TO ENSURE PROPER LIGHTNING PROTECTION TO ENSURE THAT LIGHTNING INDUCED CURRENTS DO NOT DAMAGE PROPERTY.*

- WARNING!

Do not insert any device in the RG-6 or the transmission line between the Combiner and the Controller of the SAL antenna. Most devices are a short circuit for DC and the command pulses and 15 V DC are sent to the combiner using the transmission. This can damage the device and the Combiner and Controller of the SAL antenna.

- Initial Checkout

- *Note: The controller has been designed to provide loop diagnostic capabilities to assist in initial checkout as well as troubleshooting.*
- Ensure that the controller is connected to a receiver and that it is connected to the supplied power source. Enable the noise blanker on the receiver (if available).
- Turn on the controller by pressing the PWR button. The LED's should all light and a line should rotate through the directions.
- Run the Loop Strength Test and the Loop Polarity and Array Delay Test outlined below.

The Loop Strength Test

The purpose of this test is to determine how well each pair of loops are matched. In the BI-directional mode, you are listening to only one loop at a time. This provides a convenient way to listen individually to each loop.

1. Press the BI button to select the BI-directional mode.
2. Press the direction change arrow so that the LED's point to both the northeast and southwest direction.
3. Tune to an AM Broadcast station coming from either a northeast or southwest direction that has a steady signal.
4. Observe the signal strength from the station. Then press FLIP button while observing the signal strength. Then, press the FLIP button again. **The signal from the station should be EXACTLY the same**
5. Next, press the direction change arrow so that the LED's point to the northwest and southeast direction.
6. Tune to an AM Broadcast station coming from either a northwest or southeast direction that has a steady signal.
7. Observe the signal strength from the station. Then press and hold the FLIP button while observing the signal strength. Then, release the FLIP button. **The signal from the station should be EXACTLY the same.**

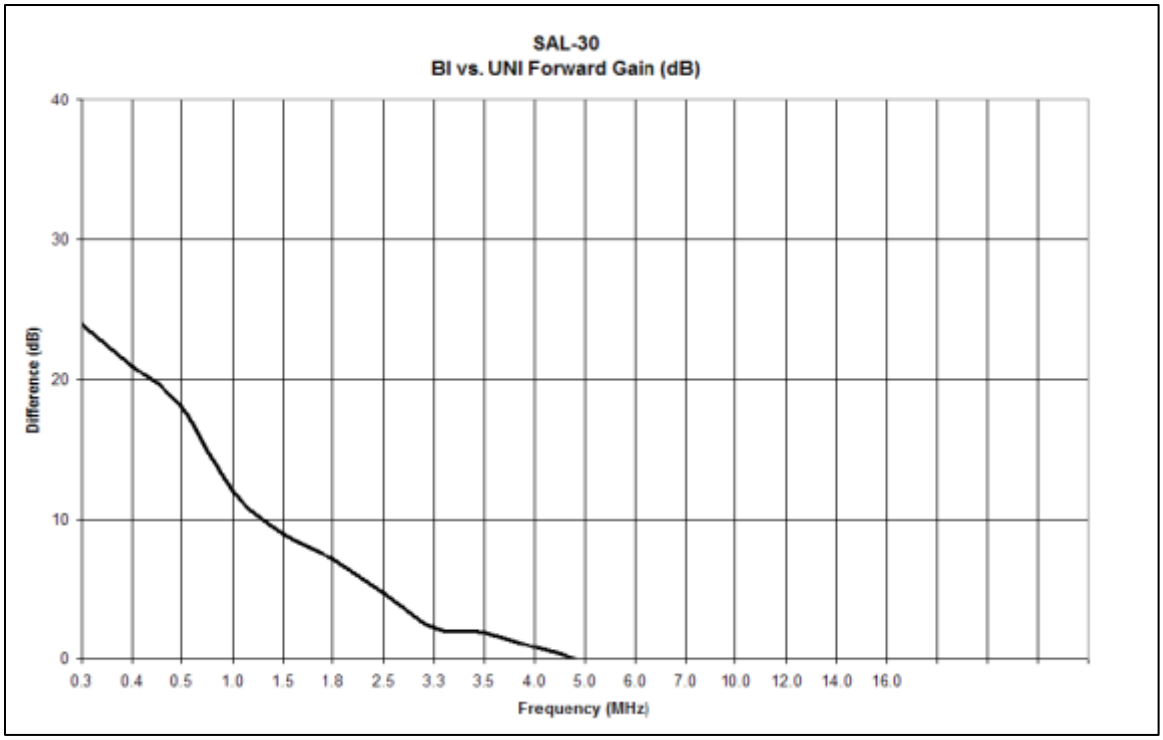
- *NOTE: If the signal strength levels are not the same, then the loops are not matched and directivity will be disappointing, especially on frequencies below 4 MHz!*

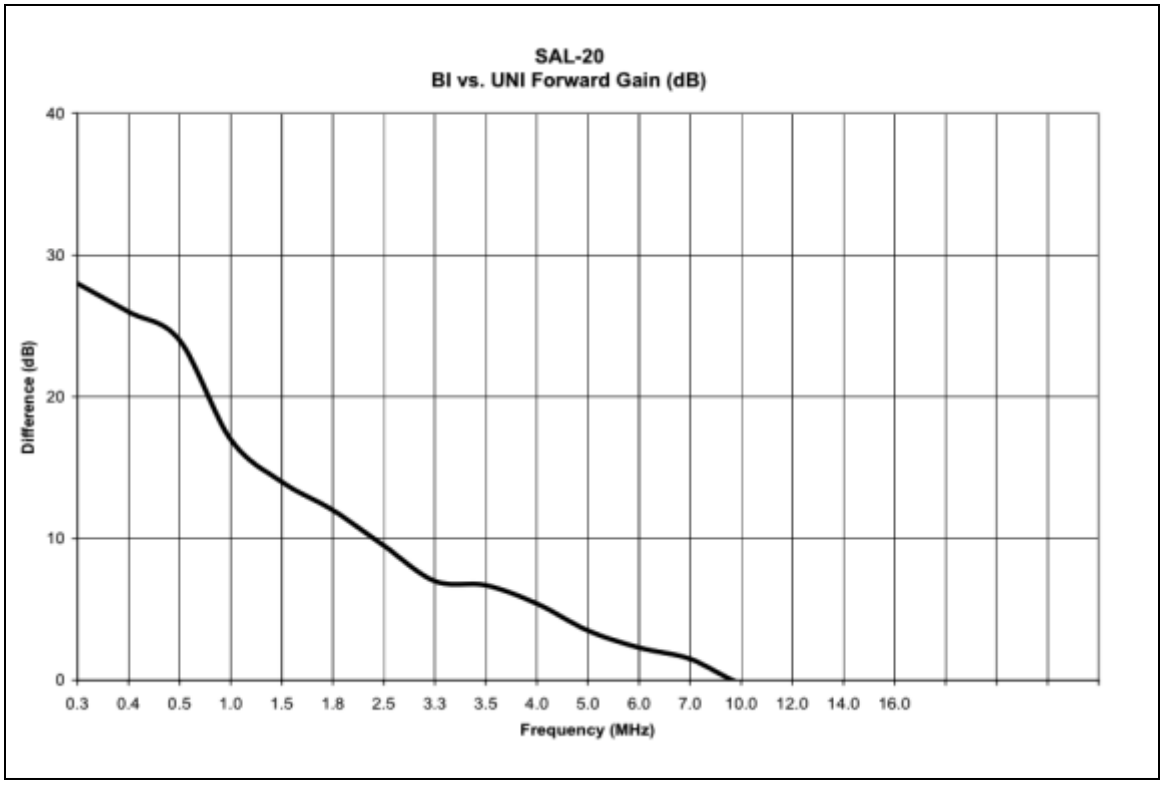
The Loop Polarity and Array Delay Test

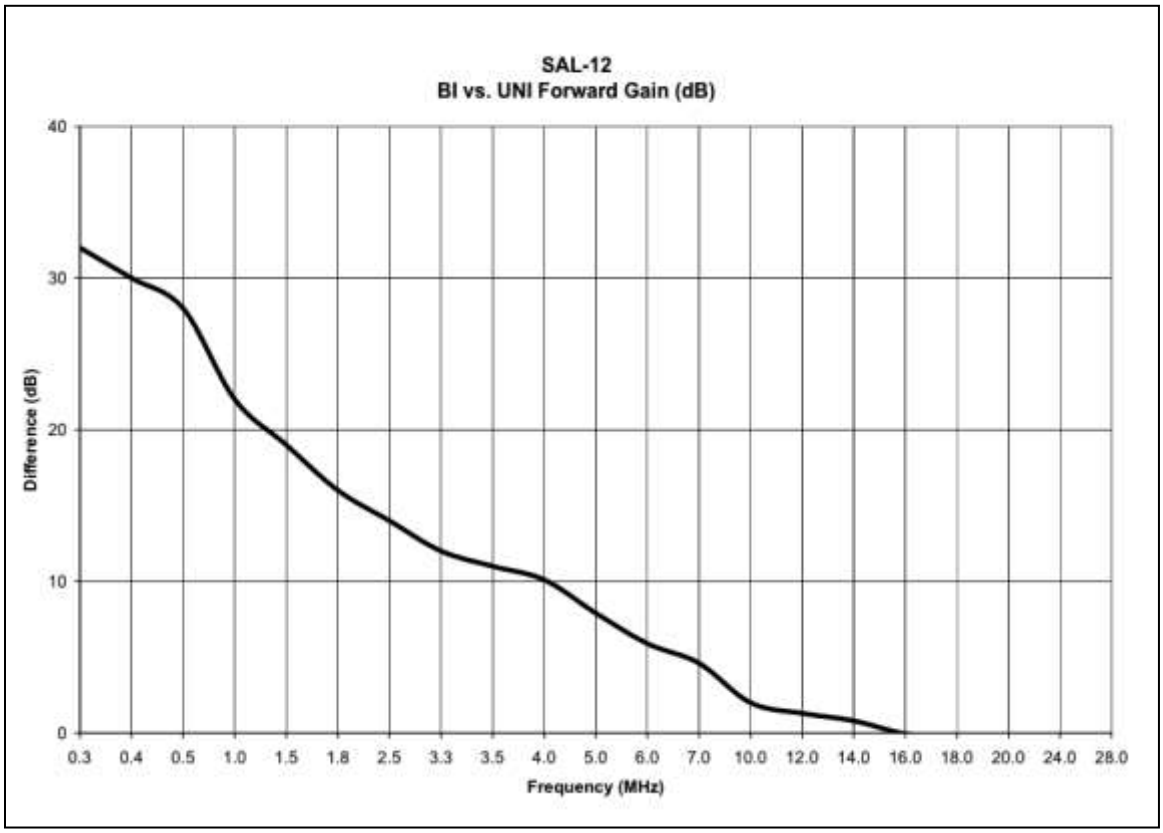
The purpose of this test is to measure the difference between signals in both the UNI-directional and BI-directional modes and compare the results to the expected results based on experience and modeling using the factory provided dimensions.

1. Press the UNI button to select the UNI directional mode.
2. Press the direction change arrow so that the LED's point to the northeast direction.
3. Tune to an AM Broadcast station coming from a northeast direction.
4. Observe the signal strength from the station.
5. Now, press the BI button to select the BI directional mode and observe the signal strength.
6. The signal in the BI mode should be much STRONGER than the UNI mode. Refer to the graphs below for your array to see what this difference should be. Note that the difference is based on the frequency For example, at 1000 KHz, the difference for the AS-SAL-20 should be 16dB and for the AS-SAL-12 should be 22dB.
7. Press the direction change arrow so that the LED's point to the northwest direction.
8. Tune to an AM Broadcast station coming from a northwest direction.
9. Observe the signal strength from the station.
10. Now, press the BI button to select the BI directional mode and observe the signal strength.
11. Refer to the graphs below for your array to see what this difference should be. Note that the difference is based on the frequency For example, at 1000 KHz, the difference for the AS-SAL-30 should be 12 dB, for the AS-SAL-20 should be 16 dB and for the AS-SAL-12 should be 22 dB.

- *Note: If you don't see a difference in the signal strength, then either the balanced feed line polarity is incorrect for the respective loop, there is a problem with the delay line connection, or the couplers are not located at the correct distance from the mast.*


SAL-30
BI vs. UNI Forward Gain (dB)
Difference (dB)
40
30
20
10
0
0.3 0.4 0.5 1.0 1.5 1.8 2.5 3.3 3.5 4.0 5.0 6.0 7.0 10.0 12.0 14.0 16.0
Frequency (MHz)


SAL-20
BI vs. UNI Forward Gain (dB)
Difference (dB)
40
30
20
10
0
0.3 0.4 0.5 1.0 1.5 1.8 2.5 3.3 3.5 4.0 5.0 6.0 7.0 10.0 12.0 14.0 16.0
Frequency (MHz)


SAL-12
BI vs. UNI Forward Gain (dB)
Difference (dB)
40
30
20
10
0
0.3
0.4
0.5
1.0
1.5
1.8
2.5
3.3
3.5
4.0
5.0
6.0
7.0
10.0
12.0
14.0
16.0
18.0
20.0
24.0
28.0
Frequency (MHz)

Optimizing the F/B

To maximize the F/B start the following procedure. Set up a transceiver on a test table 40-50 feet away from the loop and bring the feedline to the radio.

1. Start with the couplers in the suggested positions and listen to an AM or MW broadcast signal which is steady and off one of the diagonal directions. Note the F/B by using the "Flip" button to reverse the pattern.
2. Move all the couplers 6 inches closer to the mast, you may see the F/B increase or decrease. Note the F/B again,
3. Now move the couplers in the opposite direction away from the mast by 12 inches. Note the F/B. If it is worse than the other two positions put the couplers back towards the mast by 12 inches. And move the couplers 3 inches in towards the mast. Repeat until you find the maximum F/B.
4. Secure the couplers in this position.
5. It has been found that the lower frequencies are the most critical. Higher frequencies will have good F/B once you find the low frequency best F/B spot.

- NOTE: *A reliable signal source like a broadcast station which its position relative to the SAL antenna is well known can be used to optimize the front to back of the SAL antenna. Keep in mind that at times near dusk and down the propagation will change and incoming wave angles will do as well and the front to back can vary a great amount while this propagation conditions are changing.*

OPERATION

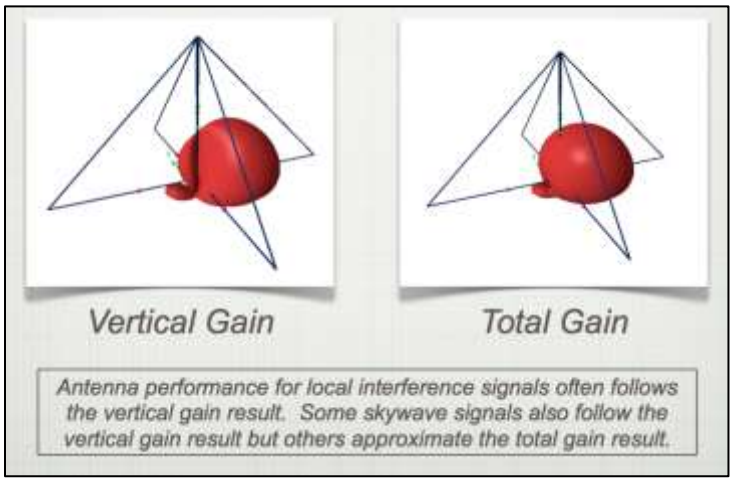
There are several buttons that you will easily use in operating your array.

1. Yellow counter clockwise and clockwise buttons will electrically steer the array, the LEDs will show the direction you are listening. Eight directions are possible.
2. FLIP white button will flip the direction 180 degrees to allow easy F/B measurements.
3. FLIP Automatic – Holding the FLIP button for 2 seconds will cause the array to flip back and forth 180 degrees every 2 seconds. Very handy for F/B measurements over time.
4. UNIDIRECTIONAL sets the array in single direction mode.
5. BI-DIRECT button places the array in Bidirectional mode. Handy for listening in opposite directions. Signals will be much stronger in this mode at lower frequencies, so it is also useful for weak signal work at low frequencies.
6. Power – power on/ power off. When off the center LED is always lit. Minimal current is being drawn (approximately 10 mA).

PLEASE NOTE —
When you first install your Shared Apex Loop™ system, we recommend that you spend plenty of time listening to gain an understanding about how the antenna works. Good sources of test signals are WWV at 2.5 (at night), 5 and 10 MHz of course, ham radio signals in the 40, 80 and 160 meter bands. AM radio stations in the broadcast band are also good, but remember that local stations may not show as much front-to-back as

distant stations. In the AM broadcast band you should be able to find two and sometimes three or more signals on the same frequency just by changing directions. Do your testing at night when the low bands are open to see the greatest performance.

Also, vertically polarized signals will exhibit both good front-to-back as well as front-to-side ratios. Often local interference sources are vertically polarized and can be attenuated by pointing the antenna away from the source.



Ionospheric conditions can impact the apparent directivity when listening to sky wave signals. Expect degraded directivity (less front-to-back and front-to-side ratio) during active and stormy geomagnetic field conditions.

If conducted shack noise is a problem, try running a short wire from your receiver to **either** the shield of the RCA cable at the controller, the RG-6 cable connector, or the (-) side of the DC power connector.

Enjoy your Array Solutions Shared Apex Loop™ System.

Specifications:

Antenna type:	Four right angle triangular loops sharing a common insulated mast
UNI-directional Pattern:	Slightly sharper than a cardioid pattern for horizontally polarized signals and much sharper than a cardioid pattern for vertically polarized signals. Electronically steerable in eight directions.
Peak front-to-back:	Greater than 30 dB
RX antenna impedance:	50 ohms nominal (At the controller's RCA output to the radio)
Delay Line impedance:	75 ohms
*Frequency range**:***	AS-SAL-12: 500 kHz to 25+ MHz
	AS-SAL-20: 300 kHz to 14 MHz
	AS-SAL-30: 100 kHz to 7 MHz
	Note that the antennas do work below and above these frequency ranges to some extent with less gain or a different pattern.
Number of Directions:	Eight directions
Direction control:	Through feed line coax, no control lines
RF connection (antenna):	Type-F (RG-6) connectors at control box and outdoor relay box.
RF connection (radio):	RCA connector output to receiver external antenna input
Power requirements:	+12 - 15 V DC, 1000 mA linear regulated RF-quiet power supply provided, 2.10 mm coaxial jack
Switching Unit Preamp:	Socketed Dual Stage Preamplifier
Size:	AS-SAL-30: 33 ft (10.06 m) tall, 33 ft (10.06 m) radius
	AS-SAL-20: 22 ft (6.71 m) tall, 25.5 ft (7.77 m) radius
	AS-SAL-12: 14 ft (4.27 m) tall, 20 ft (6.10 m) radius

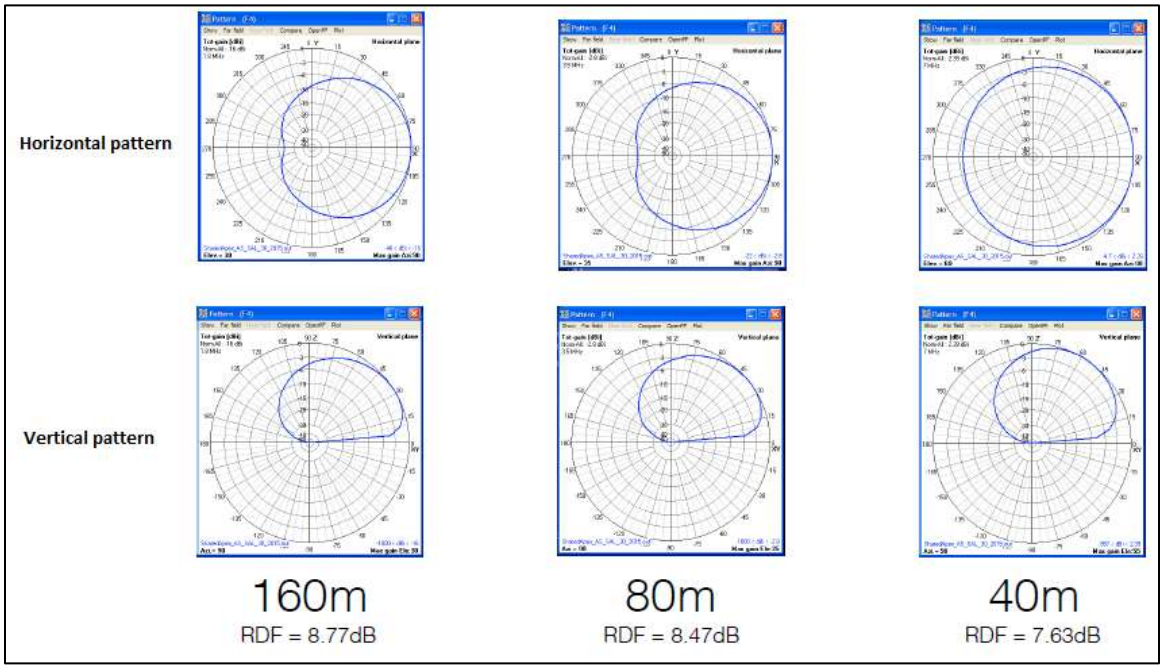
NOTE: If the outer stakes are not used and non-conductive posts are used to anchor the loops' outer corners, the footprint of the antenna can be reduced as follows:

AS-SAL-30: A square of 35.4 feet (10.79 m) on a side

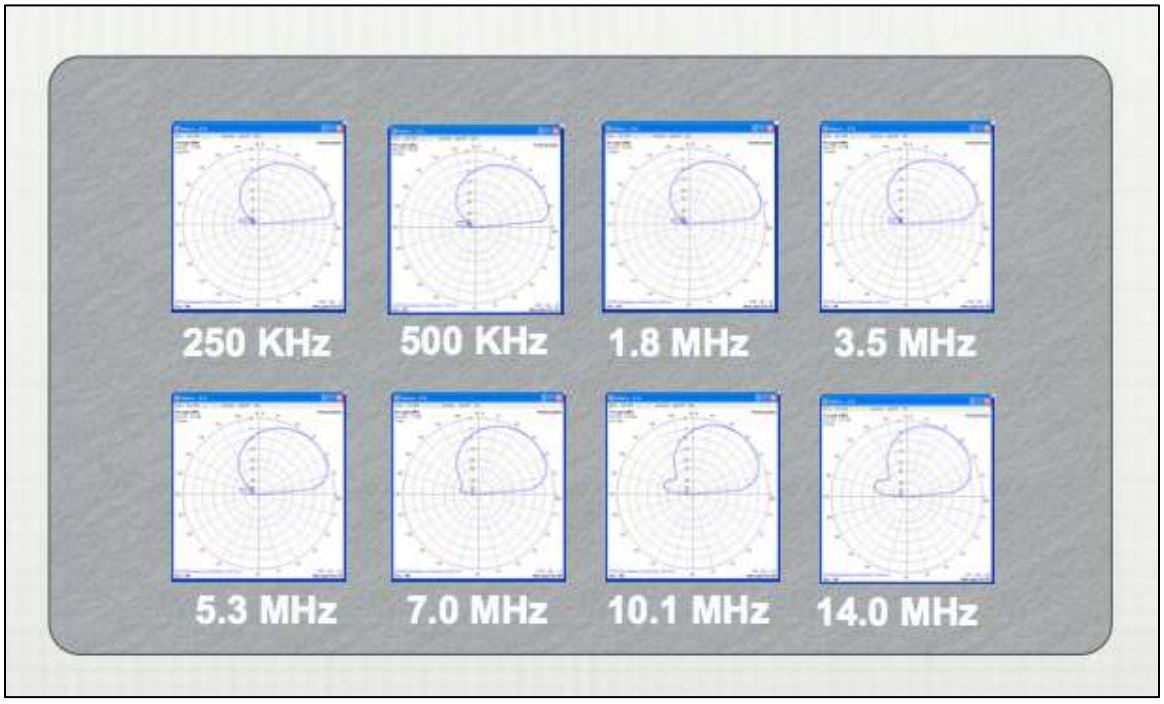
AS-SAL-20: A square of 24.75 feet (7.54 m) on a side

AS-SAL-12: A square of 14.85 feet (4.53 m) on a side

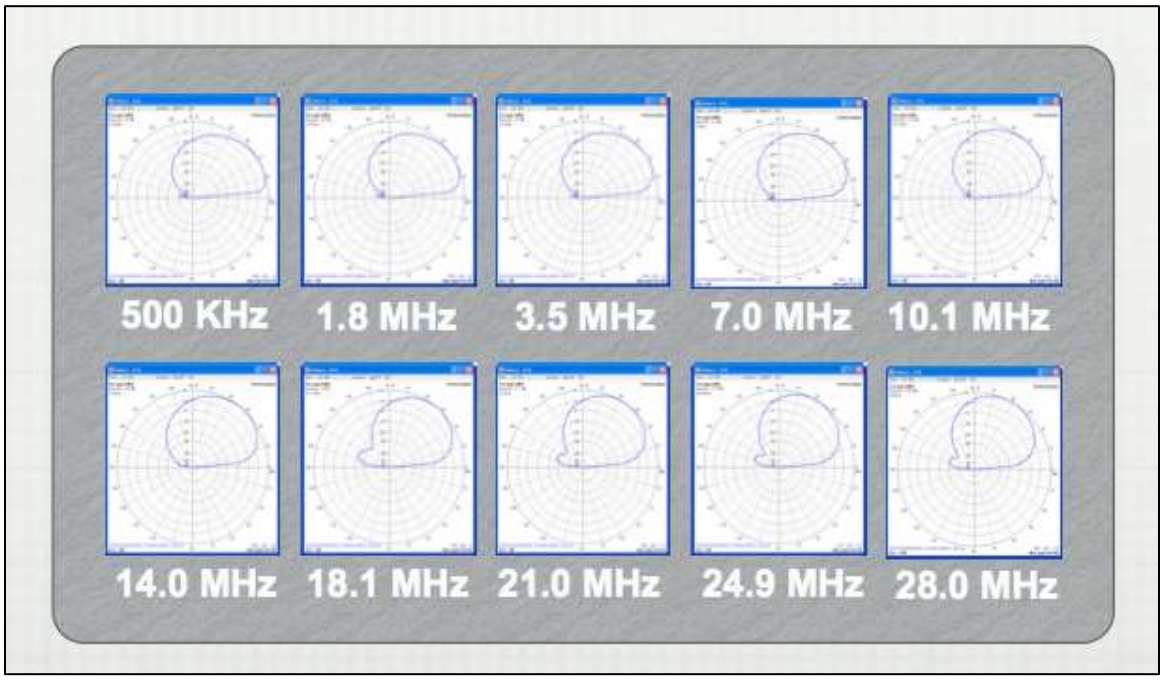
AS-SAL-30 Example Elevation Response Patterns



AS-SAL-20 Example Elevation Response Patterns



AS-SAL-12 Example Elevation Response Patterns



Appendix 1.
Erection method for the SAL-30 antenna.

The procedure described here can be and has been executed by two persons with the prototype SAL-30 antenna. Obviously, using more helpers would make the task easier, safer and speed up the installation. Do not attempt on a windy day. If you do not have any or little experience erecting masts and/or antennas, ask for help.
First, define the location of the SAL antenna mast and set the stakes positions. Recommended distances and ropes lengths needed may vary depending on the topography of the site. On a flat terrain the inner stakes should be 16 – 17 ft (c.a. 5.00 m) from the mast. The outer stakes should be set around 31 - 33 ft (c.a. 9.75 m) from the mast. See Figure 1 for reference while reading through this manual.

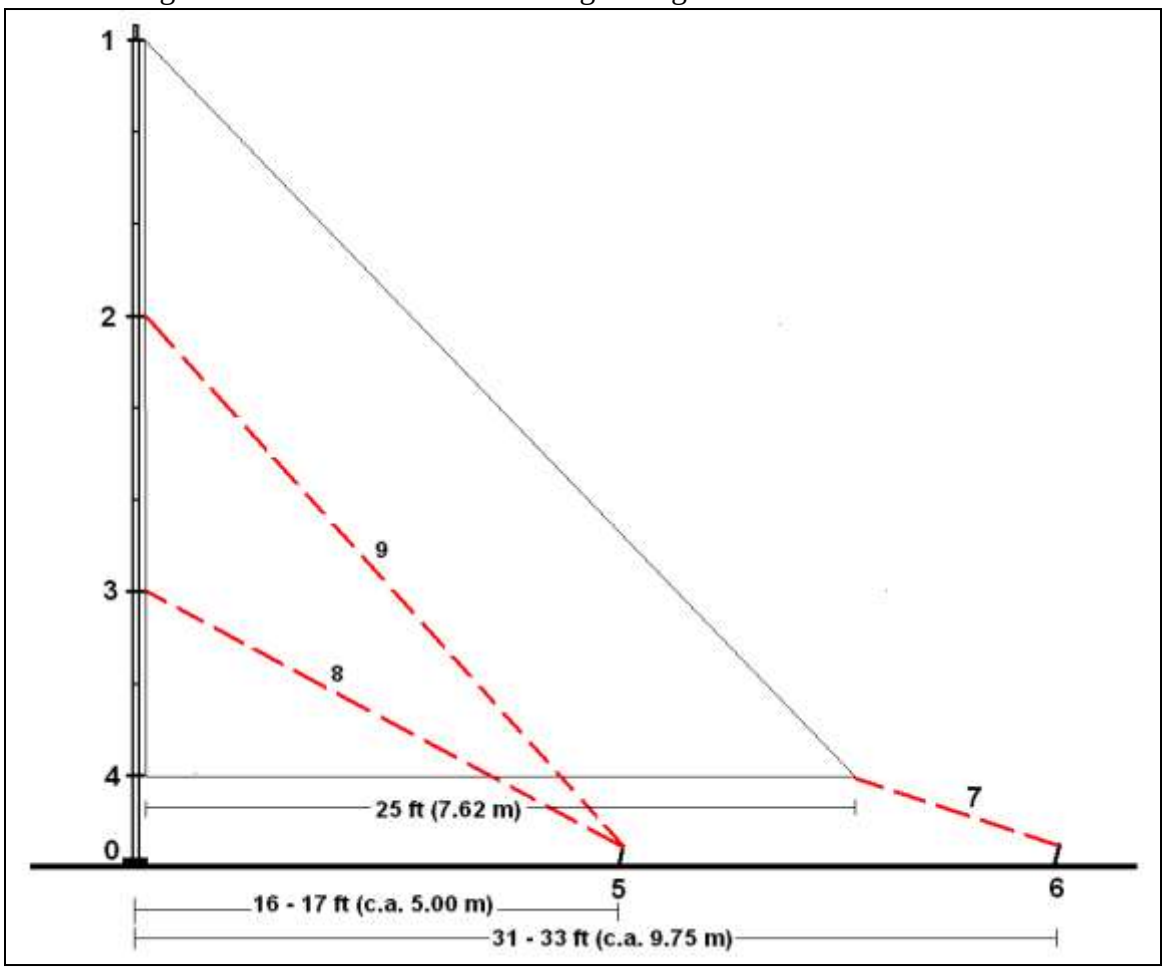


Figure 1. Layout for each one of the four loops of the SAL-30 antenna

1-Top guy ring, thicker than the rest. Only the loops wires are threaded here
2-Second guy ring to attach the 32 ft (9.75 m) rope (9) and tie it down to inner stake (5). Loops wires are also threaded through this and all of the other guy/loop wire rings
3-Third guy ring to attach the 28 ft (8.53 m) rope (8) and tie it down to inner stake (5). Thread wires as well.
4-Bottom guy ring. Only the loops wires are threaded here.
7-Outer ropes, 10 ft (3.05 m) length, to anchor the outer corner of the loops to the outer stakes (6).
0-Provided Mast base.

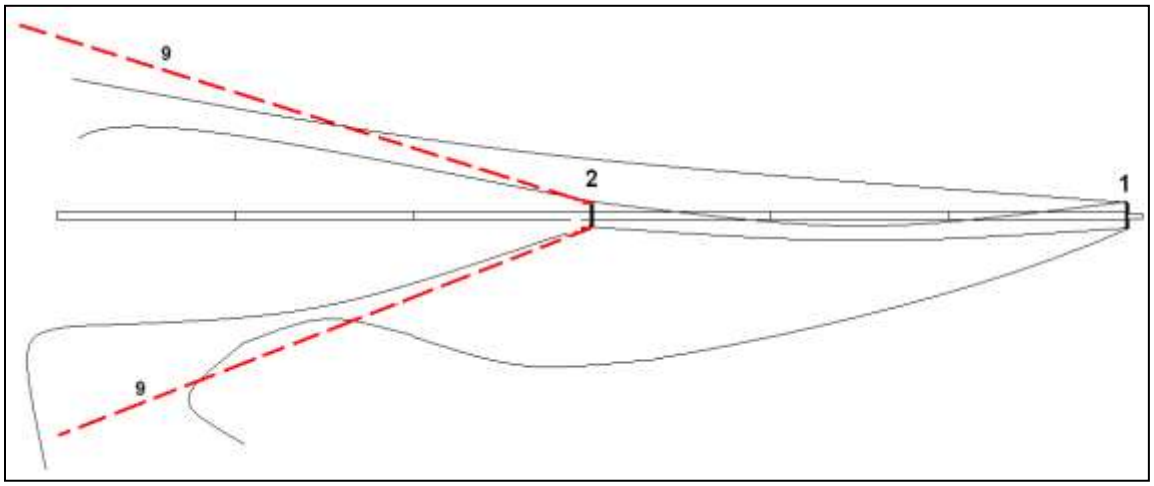


Figure 2. Assembling six sections on the ground.

Assembly a maximum of 6 mast sections laying on the ground as shown in Figure 2 and thread the loops wires (solid-thin) through the top two guy/wire rings (1 and 2), tie the four 32 ft guy ropes (dashed- thick and red if printed in colors) to the number two ring (2). There should be three mast sections between 1 and 2, and three below 2 (to the left of 2 in the figure above). Slide enough wire so the loop closing splice will be no more than 5 ft (1.52 m) from the mast to allow room for the coupler to slide on the loops wires while adjusting the antenna. (Pull enough wire from the top ring (1) along the mast and beyond to have no more than the length of the nine sections)

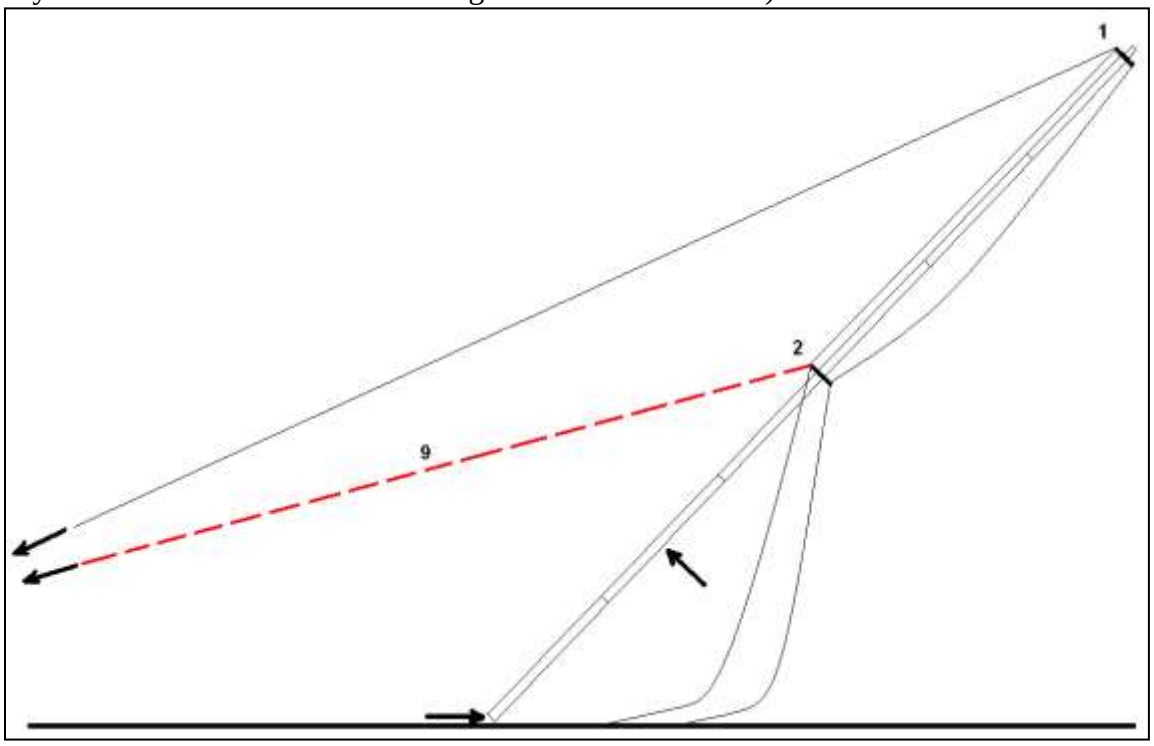


Figure 3. Lifting the six sections to the vertical position.

Once assembled on the ground and the guy rings aligned to route the wires of the loops in their correct positions relative to the mast, start raising the assembly pulling and pushing at the points indicated by the arrows in Figure 3 using the wires and the ropes (9).

GENTLY PULL THE WIRES AND ROPES WHILE THE MAST IS BELOW THIRTY DEGREES ABOVE THE HORIZONTAL, if too much compression is exerted on the mast by pulling the ropes and/or wires hard, it is possible to bend and buckle the mast. A provisional stake or any other means of holding the base should be used at the bottom to avoid slippage while raising the mast to the vertical position.

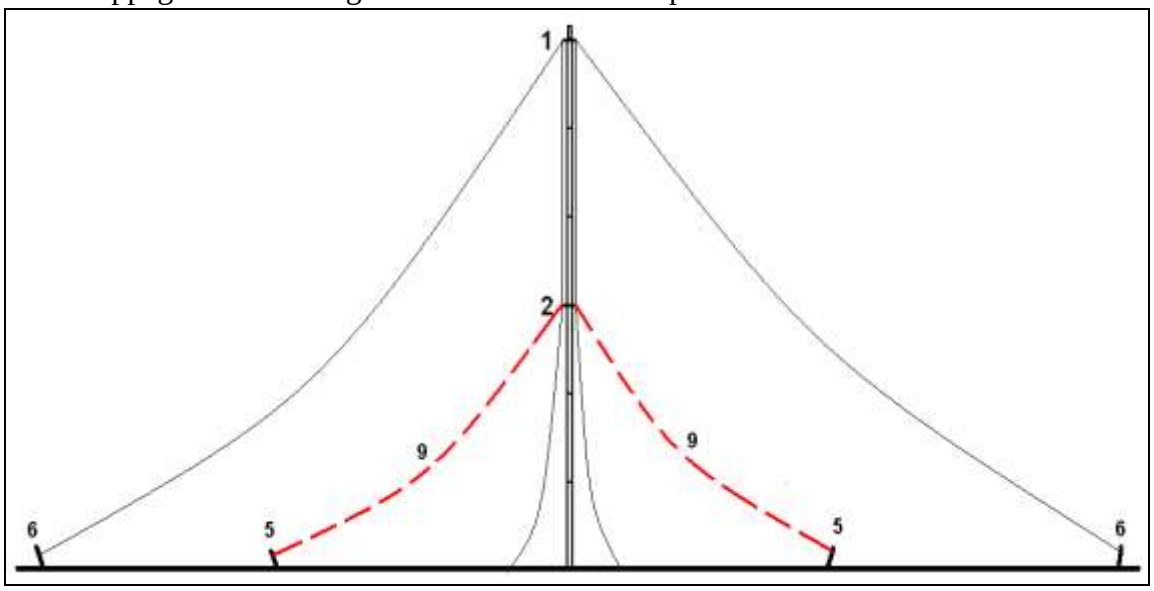


Figure 4. Securing the six sections of mast using the loops wires and ropes loosely.

Once in the vertical position, tie the loops wires to the outer stakes (6) and the 32 ft (9.75 m) ropes (9) to the inner stakes (5) as shown in Figure 4. The ropes and wires should be loose enough to allow lifting the mast at least 4 ft (1.22 m) to have enough room to insert the seventh mast section underneath the assembly. Before raising the mast to insert the next section (seventh), put the third guy ring (3) on top of it. See Figure 5.

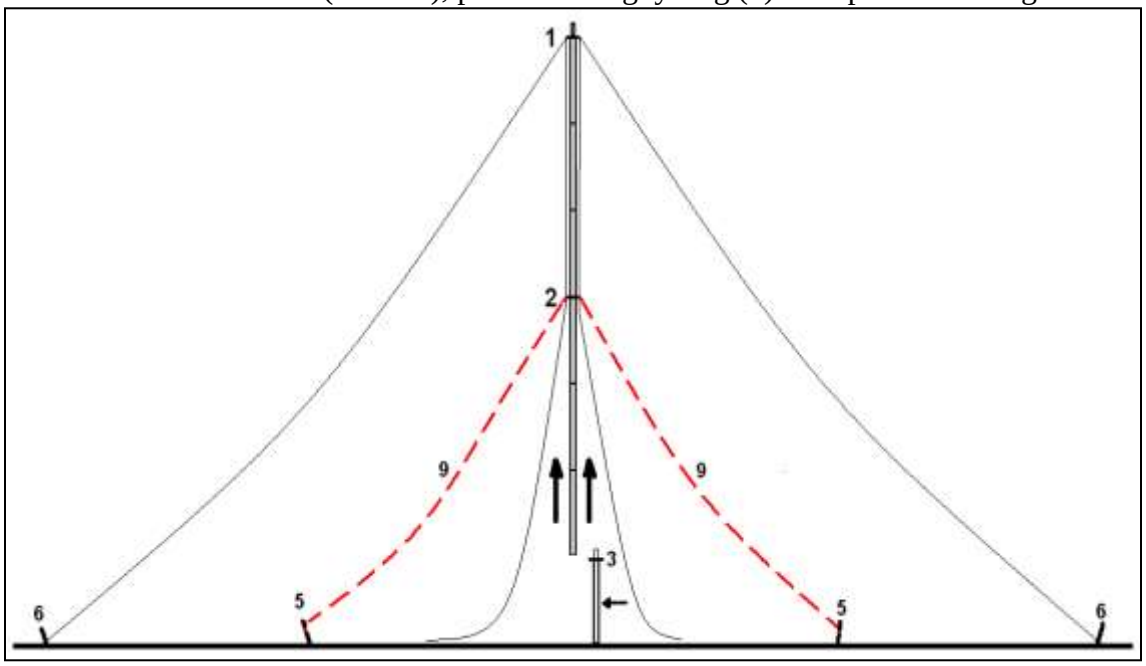


Figure 5. Lifting the six sections to insert the seventh section with third ring (3) on its top.

After inserting the seventh section of mast with its guy ring (3), tie the 28 ft (8.53 m) ropes (8) to the guy ring and to the inner stakes (5) as shown in Figure 6.

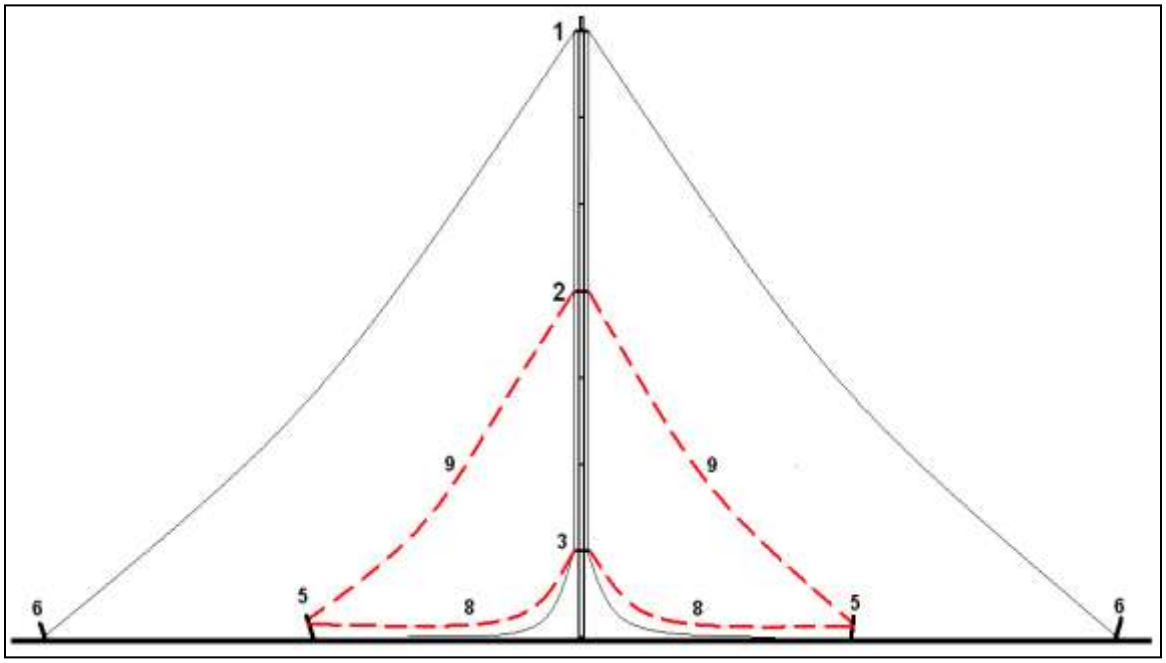


Figure 6. Installing the 28 ft (8.53 m) ropes and preparing wires and ropes loose to lift the seven sections of mast to insert the eighth.

Loose once more the wires attached to the outer stakes (6) and the ropes (8 and 9) attached to the inner stakes (5) with a slack enough to have room to insert the next section (eighth) at the bottom of the assembly. Next, repeat the process to insert the last mast section (ninth) with the mast base provided and the fourth guy/wire ring (4) at the top of the section as was done with the seventh. Afterwards, adjust the tensions on all ropes to straighten the mast in the vertical position. This must be done adjusting the bottom ropes (8) first and then middle ropes (9) and then the 10 ft (3.05 m) ropes (7) which are used to anchor the outer corner of the triangular loops to the outer stakes(6). DO THIS AFTER EACH LOOP WIRE IS PASSED THROUGH THE FERRITE COUPLERS AND THE TWO LOOSE ENDS OF THE LOOP ARE SPLICED AND SOLDERED TOGETHER. Adjust the outer ropes (7) keeping a 25 ft (7.62 m) length for the horizontal side of the loops.

Appendix 2.

Erection method for the SAL-30 when upgrading from the SAL-20 antenna.

Installation of SAL-30 when upgrading from SAL-20.

Please refer to the erection of the SAL 30 antenna in Appendix 1 of this manual to understand how the mast must be handled by giving some slack to the wires and guying ropes enough to raise the assembly and insert the additional sections of mast underneath one at the time.

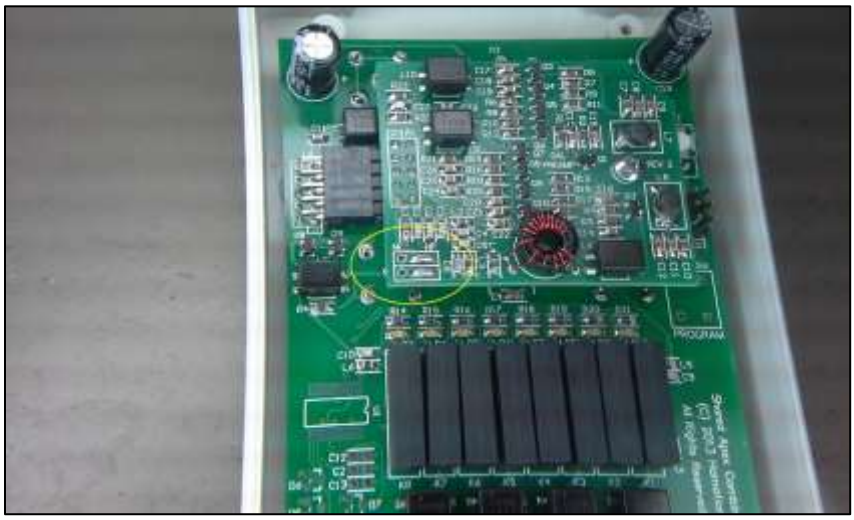
First, the 33 ft (10.06 m) lengths should be added by unsoldering the splices of the SAL-20 loops. The new splices should be away from the optimal point of front to back tuning which is 153 inches (3.89 m) from the mast located on the horizontal wire of the new SAL-30 loop.

Depending on where the splice was located when your SAL-20 was installed you may proceed to add the 33 feet (10.86 m) sent in the SAL-20U30 upgrade or it may be necessary to bring the mast down and slide the wires through the guying rings to place the splices in a convenient location and afterwards follow instructions for the SAL-30 erection.

Refer to the loop layout graph on page 19 of this manual to check the location of the guying rings in the SAL-30 which are every three sections counting from the top. The bottom guying ring (fourth) is two mast sections below the third ring.

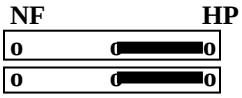
Read carefully the instructions for the SAL-30 erection and do not attempt to install during windy weather. Check the new distances and height of the SAL-30 antenna to make sure that there is a safe distance to electric power lines. Do not attempt to raise the mast totally assembled on the floor, the mast will be damaged and personal injuries may happen.

Appendix 3.
Bypassing the High Pass Filter of the SAL preamplifier.



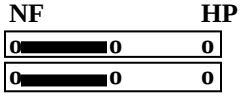
HPF Connected.

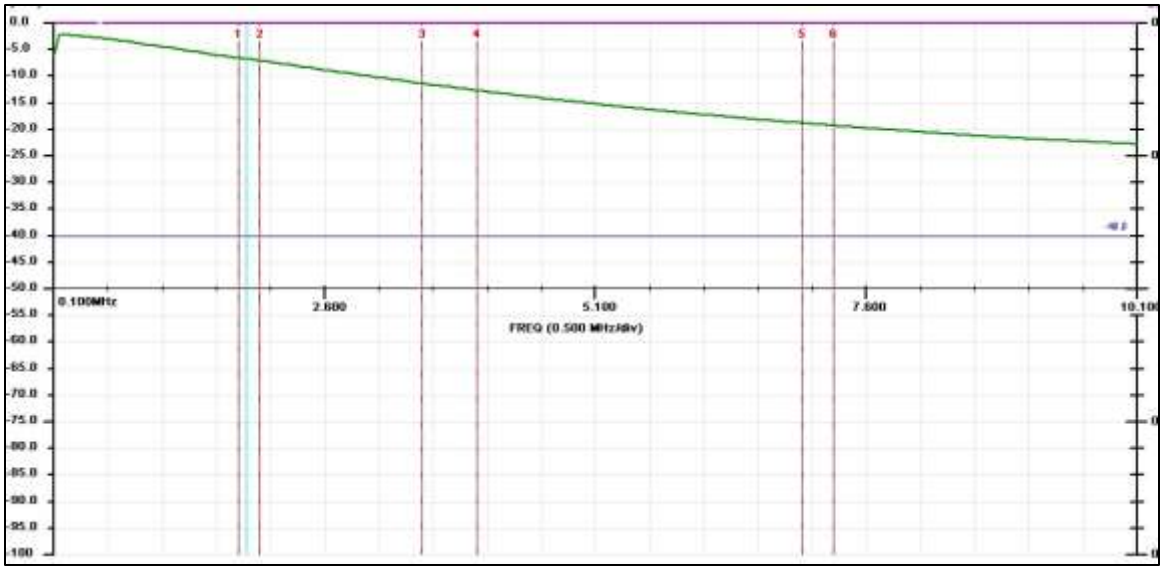
It can be seen in the image above, that there are two solder lines in place on the lower left corner of the small "daughter board", between the center contacts and the HP (High Pass) contacts.



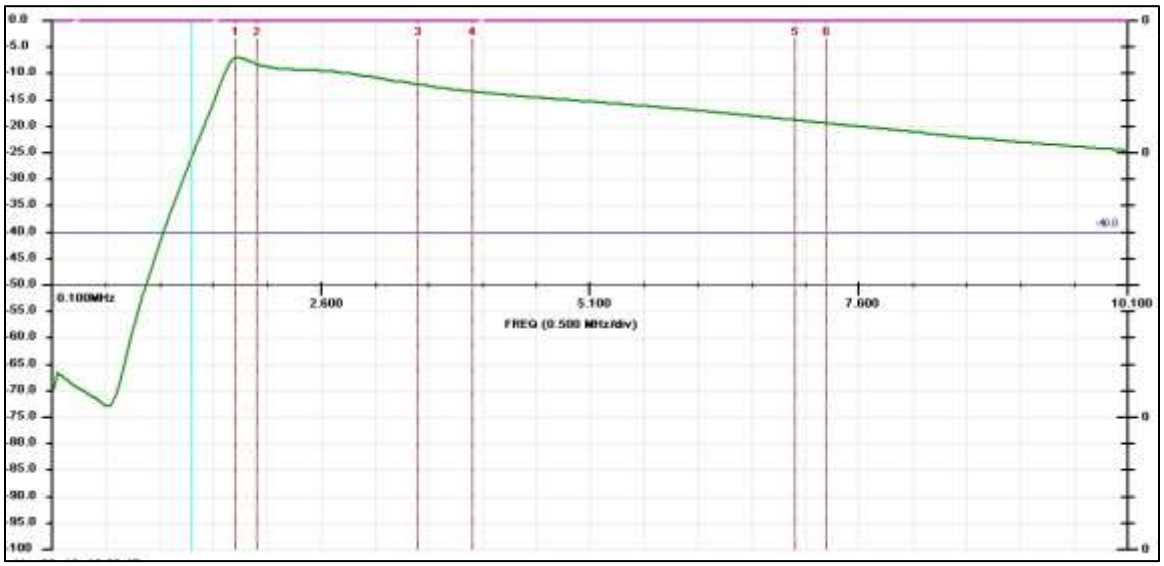
To bypass the filter, remove the solder with a wick or a solder sucker, use minimal heat.
Then, solder jumpers or make a trace with the solder from the center contacts to the NF (No Filter) contacts.

HPF Bypassed.





SAL antenna combiner response with no BCB High Pass Filter. The plots have been padded down because of the preamplifier gain, therefore, add 40 dB to the numbers.



SAL antenna combiner response with BCB High Pass Filter. The plots have been padded down because of the preamplifier gain, therefore, add 40 dB to the numbers.