A18-4-1

LSCA-#2

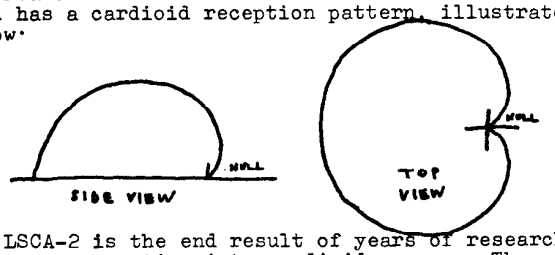
CONSTRUCTION PLANS

§ Ron Schatz §

The LSCA-2 is a practical cardioid array. Its unique reception pattern permits it to do things that are impossible with an ordinary loop; e.g.,

1) Separate stations lying in opposite directions (i.e., 180° apart).
2) Null out as much as an 180° sector of stations.
3) Resolve the "180° ambiguity" for DF purposes.
4) Under certain conditions, receive distant stations through a local in the same direction.

The reason behind these "miracles" is that the LSCA has a cardioid reception pattern, illustrated below.



The LSCA-2 is the end result of years of research and experimentation into cardioid arrays. The extreme instability, delicacy and unpredictability that once discouraged their use have largely been overcome, so that the LSCA-2 is intended to all but replace the ordinary loop for DX'ing purposes. The LSCA-2 is an advanced model of the LSCA-1, construction plans for which first appeared in the NRC's DX NEWS of 10 March 1975; new features have been added to the LSCA-2 to improve pattern control and the "cardioid effect".

The LSCA-2 may be described as a tri-sectional combination of loop, longwire, and control unit:

1) LOOP SECTION - a 6-turn, 2-band, low-Q, altazimuth, unbalanced spiral loop. Although it is designed primarily for use in the cardioid mode, it can serve as a better-than-average figure-8 loop as well. The altazimuth feature is for use only in the figure-8 mode.
2) SENSE SECTION - a "longwire" pair, one 20 to 40 meters in length, the other one-third that length, combining into a shielded lead-in. The exact length and lay of the longwire is left to the builder's experimentation.
3) CONTROL SECTION - a commercially-available FET amplifier along with those switches, capacitors, and potentiometers necessary for tuning and operation.

(WARNING: The LSCA-2 is three times as hard to build and to operate than an ordinary loop. Experience in loop construction and cardioid theory is is a prerequisite for building this device. This is definitely not a project for beginners!)

Parts and components used in the LSCA-2 are all commonly available; with the possible exception of the FET amplifier, no part need be specially ordered. In the United States, Calectro and Archer products are available from Heathkit, Lafayette (LRE), Radio Shack, and similar outlets in all major cities. Some Calectro part numbers are included in the following list:

LSCA-2 Parts List

(All non-relative dimensions are in centimeters).

Wooden sections:
- A) 2.7 x 2.7 x 152 cm. (loop X-arm, vertical)
- B) 2.7 x 2.7 x 150 cm. (loop X-arm, horizontal)
- C) 2.7 x 2.7 x 50 cm. (altazimuth brace, horiz'tal)
- D) 2.7 diameter x 100 cm. dowel (loop axle)
- E) 2.7 x 2.7 x 80 cm. (altazimuth brace, diagonal)

Plexiglas or plastic sections:
- F) 16 x 16 cm. (loop center brace)
- G) 7 x 16 cm. (control mounting board, front)
- H) 7 x 10 cm. (control mounting board, rear)
- I) 2 x 9 cm. (loop-winding spacers, 8 needed)
- J) 3 x 8 cm. (altazimuth holding plate)

Metallic parts:
- K) 7.6 x 5 x 13.3 cm. (chassis box, front section)
- L) " " " (chassis box, rear section)

Wire and cable:
- W1) "Speaker" wire, no. 14 AWG, 25 meters.
- W2) "Speaker" wire, no. 16 AWG, 5 meters.
- W3) "Speaker" wire, any AWG, 50 meters unsplit.
- W4) Co-ax cable, RG-58/U, loop-receiver length /plus slack.
- W5) Co-ax cable, RG-58/U, loop-longwire length (2 needed!) /plus slack.
- W6) Insulated hook-up wire for control-box con-/nexions.

Hardware:
- T1) Nut-bolt combo, .5 x 4 cm. (6 needed)
- T2) Nut-bolt combo, .5 x 7 cm. (2 needed)
- T3) Wingnut-bolt combo, .5 x 7 cm. (2 needed)
- T4) Wood screw, 9 cm. (1 needed)
- T5) Machine screw, .5 x 1 cm. (27 needed)
- T6) Misc. hardware necessary for mounting FET amplifier and tuning capacitor (screws, spacers, nuts, etc.)

Electrical components:
- B1) Standard 9-volt transistor battery.
- C1) Capacitor, tuning, 10-365 pf, A1-227.
- C2) Capacitor, silver mica, 330 pf, A1-011.
- R1 & R2) Potentiometer, 10 kΩ, B1-683 (2 needed).
- S1, S3 & S4) Toggle switch, miniature, SPST, /E2-116 (3 needed).
- S2) Toggle switch, miniature, DPDT, E2-118.
- S5) Toggle switch, miniature, SPDT, E2-117.
- X1) 9-volt battery connector, F3-052.
- X2) Knob, calibrated 0-9, E2-729 (3 needed).
- X3) Vernier dial, 4 cm. diameter, E2-744 (2 needed)

Items obtained beyond these instructions:
- A1) FET amplifier of the printed-circuit board type, small enough to fit into part L. Either the "BCB Super-Booster" or the BAX-1 is recommended. Remove and/or omit any accompanying coil and tuning capacitor.
- Y) Loop base stand, should accomodate part D, complete with circular protractor, pointer, etc.

Have the above two items under control before beginning.

Building the LSCA-2

1) Wires W1, W2 and W3 are 2-conductor. Split apart W1 and W2 completely. Split W3 only for two-thirds (2/3) of its length, then cut off one of the split sections at the base of the split.
2) Prepare wooden sections A through E as illustrated. Drill holes just wide enough to accomodate hardwire and wire indicated. Wood screw T4 is to screw into the stub of C; take care to center its socket exactly. The two W1 holes on A should be of a diameter that W1 will be drawn through with notable effort but without tearing the insulation; this is designed to hold the wire in place.
3) Prepare plexiglas sections F through J as illustrated. The material cracks easily, so take care when drilling and cutting. Not illustrated on G are 4 screw holes necessary for mounting the two vernier dials so that their respective "Y" marks point directly away from each other on a NE-SW line. The mounting holes for capacitor C1 are likewise not illustrated. On H the holes necessary to accomodate the holding tabs of pots R1 and R2 are not illustrated; the pots will face shaft-forward with leads downward. These components must be used to determine the correct positions and sizes of these holes.
4) Prepare aluminium chassis K and L as illustrated, including cutting off the four back corners on K. On L, drill extra holes as necessary in order to mount the FET amplifier board to the rear inside surface.
5) Assemble loop cross-frame as illustrated with parts A, B, F, and T1 hardware. Insert bolts via wood side; affix nuts to plexiglas side.
6) Lay cross-frame on the floor with A on top and B on the bottom. Implant six (6) small machine screws T5 halfway into each end of B as indicated - with a 1.5-cm spacing.

7a) Turn cross-frame over. Likewise implant six T5 screws into the holeless end of A. These screws will face in the opposite direction from those in B.

7b) Implant five (5) T5 screws at 1.5-cm intervals between the W1 holes at the opposite end of A.

8) Mount chassis section L onto holed end of A (opposite machine screws), inserting two T1 bolts via the chassis side.

9) Wind the loop primary with W1 wire, 6 turns around the T5 screws, anchoring ends through W1 holes in L via A. Tighten windings as much as possible. Adjust T5 hights as necessary for a neat fit. Put the loop assembly aside for now.

10) Carefully trim the shafts of potentiometers R1 and R2 to a length of exactly two (2) cm.

11) Mount R1 and R2 onto H; refer back to Step 3.

12) Remove shaft holding screws from vernier dials X3. Mount the dials, as per Step 3, on the front side of G, using appropriate hardware. Mount tuning capacitor C1 to the rear side of G, again using appropriate hardware. Replace shaft screws back onto X3.

13) Mount FET amplifier onto inside surface of L with appropriate T6 hardware. Use minimal length matellic spacers to clear surface of L yet ground amplifier to it. "Working/soldering" surface of A1, of course, must face outward so that necessary connexions may be made.

14) Mount assembly G onto chassis side of A so that bottom of G rests flush against top side of L and dial knobs face forward. Affix with two small machine screws T5.

15) Mount assembly H onto opposite side of A. Insert shafts of R1 and R2 into respective sockets of dials X3, then affix with two T5 screws onto A.

16) Rotate R1, R2, and the X3 dials to their extreme clockwise limits; tighten the X3 set screws.

17) Mount the five toggle switches onto K so that they flick vertically, locating them as illustrated.

18) Use insulated hook-up wire to connect opposite corner lugs of switch S2 "criss-cross" fashion as illustrated.

19) Hook up power circuit for FET amplifier A1 as illustrated, using X1 and S3. 9-volt transistor battery B1 is to lie loose on the bottom of L.

20) Connect ends of the primary winding to tuning capacitor C1. (It may be wise to retighten the windings once more before soldering).

21) Hook up band-change circuit as illustrated, using switch S1 and capacitors C1 and C2. Use electrical tape or "spaghetti" to insulate the leads of C2, or cut them short and bridge with W5.

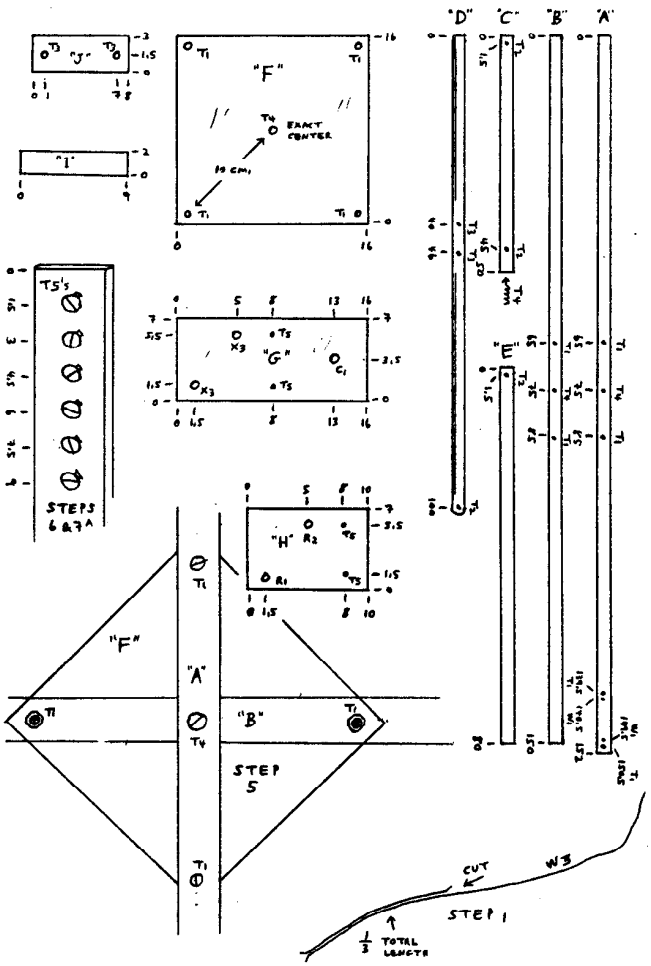
22) Wind the loop secondary with W2, paralleling the third primary winding from the outside. Double back ends around appropriate machine screws at the bottom of A, then bring them into chassis L through the rear via the W2 holes. After drawing the winding tight, tie holding knots at each W2 hole, then connect each end to the nearest respective center terminal of switch S2.

23) Use a piece of co-ax W4 or W5 to connect the center terminal of R1 to one "criss-cross" of switch S2. Connect the co-ax shield to the other "criss-cross" of S2 and to amplifier ground.

24) Use a second piece of co-ax to connect the center terminal of R2 to the center terminal of switch S4. Connect the shield to amplifier ground. Leave some shield exposed at the S4 end.

25) Use W5 to connect the right-hand terminal of potentiometer R1 to the signal-input terminal of the FET amplifier.

26) Similarly connect the right-hand terminal of R2 to the center terminal of switch S5.



27) Connect the bottom terminal of switch S5 to the signal-input terminal of the FET amplifier. Connect the top terminal of S5 to amplifier ground.

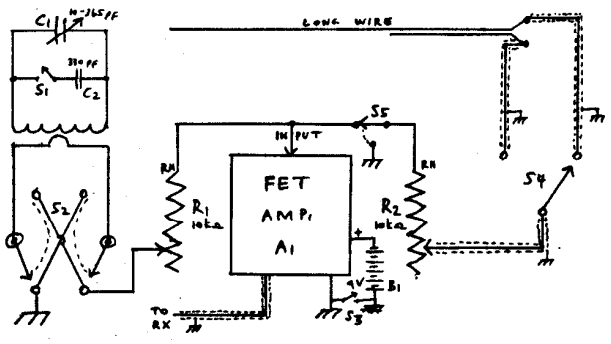
28) Connect co-ax W4 to the signal-output terminal of the FET amplifier; connect the shield to amplifier ground. Prepare the opposite end of W4 for connexion to the antenna terminals of your receiver.

29) At this point string longwire W3 outdoors in the customary manner - with the twin-conductor end leading in through the window.

30) Use one length of co-ax W5 to connect the top terminal of switch S4 with the "long" conductor of W5.

31) Using the remaining length of W5, connect the bottom terminal of S4 to the "short" conductor of W5. Connect the three shields at S4 together.

32) Check over above steps carefully for errors; see that the electrical connexions agree with the schematic diagramme below:



33) Attach the 9-volt battery to its connector X1, then close the chassis box with the two screws provided. Be very careful not to pinch wires, short components, etc. All cables and wires exit via the four triangular corner holes as appropriate.

34) Turn the loop assembly over (A-side down). Use wood screw T4 to attach C to B at center of brace so that the holes in C run parallel to the length of B.

35) Loosely attach holding plate J to dowel D using T3 hardware.

36) Place dowel D in loop-base socket, plate-end down. Attach C to J-side of D via nearest hole to brace on C and top hole on D using T2 hardware.

37) Attach diagonal brace E to C with T2 hardware (on J-side of C), then feed loose end of E between D and J. Tighten holding-plate assembly to hold the loop assembly in vertical position.

38) Thread the 8 spacers through the loop windings (in and out), 2 per side, alternating the initial feed of each spacer so as to form two diamond-shaped "cavities" when viewed from the side once the spacers are twisted perpendicular to the loop windings. Aim the spacers toward the center brace of the loop rather than 90° to the windings.

39) Attach knobs X2 to R1, R2 and C1. Connect co-ax W4 to the antenna terminals of your receiver.

40) If so desired, label the controls as follows:

R1	"LOOP GAIN"
R2	"SENSE GAIN"
S1	".5 - .8" (top) / ".8 - 1.7" (bottom)
S2	"PATTERN ..." (top) /."REVERSE" (bottom)
S3	"POWER ON" (top) / "OFF" (bottom)
S4	"CARDIOID" (top) / "COSINE" (bottom)
S5	"SHORT" (top) / "LONG" (bottom)

And that completes construction of your LSCA-2. Stand back and admire your work!

Control Descriptions

The various controls on your new LSCA-2 may at first seem as bewildering as an airline cockpit to a layman, but it's not all that bad - really! Here is a brief description of each:

TUNING CAPACITOR - Just like on the regular loop; on rare occasions you may choose to "detune" it slightly to help perfect the cardioid pattern.

POWER ON - OFF - Self-explanatory. Be sure to leave the handle pointing DOWN (to "OFF") after finishing your DX session; it helps to save the battery!

CARDIOID/COSINE - If you wish to use your LSCA-2 like an ordinary loop, then point it downward. The "CARDIOID" position will NOT automatically give you a unidirectional pattern; it must be tuned in with some of the other controls.

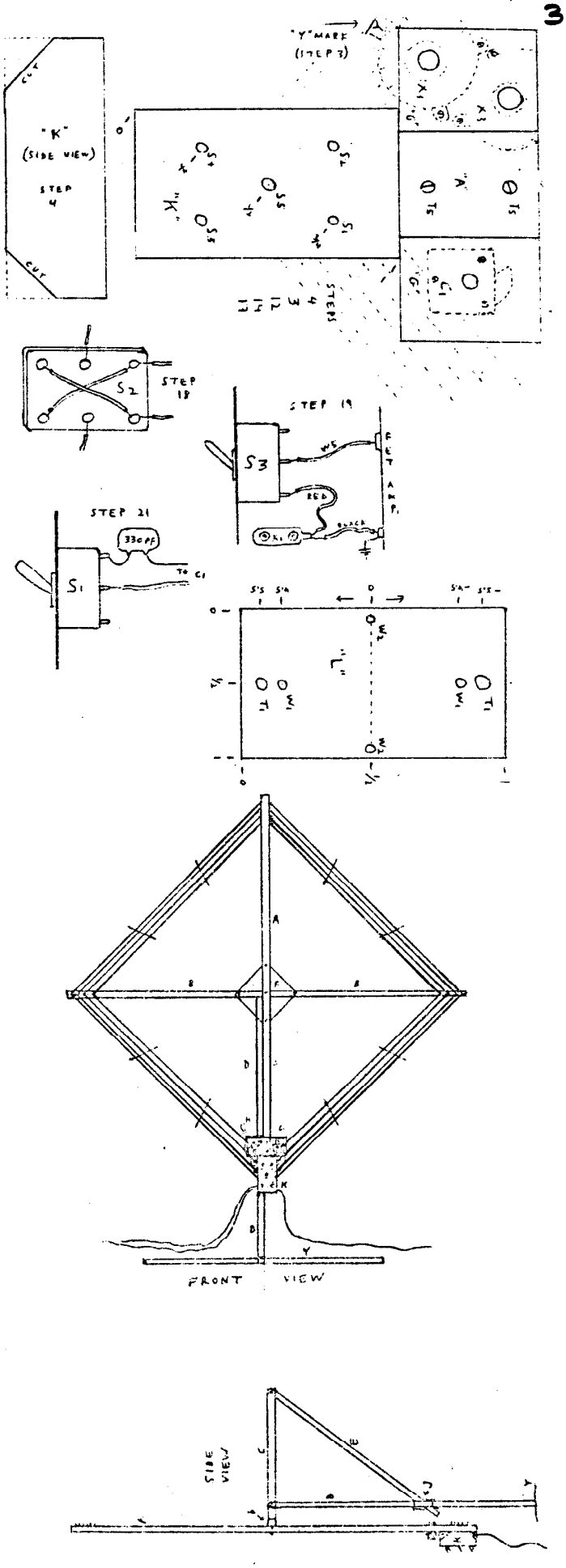
.5-.8/.8-1.7 - This is simply a "band-changing" switch; most good loops have one. It divides the BCB at about 800 khz, making for easier tuning and wider range.

PATTERN REVERSE - During normal DX'ing a cardioid loop must rotate over twice the sector of an ordinary loop; that one null must cover a complete circle! This switch automatically flips the cardioid pattern 180°, not only saving awkward acrobatics on your part but also making cardioid tuning a heck of a lot easier!

LONG/SHORT - This switch selects the length of longwire that best helps to form the cardioid pattern.

GAIN Controls - Self-explanatory.

ALTAZIMUTH AXIS - Simply, signals from local stations tend to arrive bent at an angle, so



your loop must be bent at that angle in order to null them effectively in the figure-8 mode.

Initial Testing

1) Point all switches down and rotate the two gain controls to their extreme clockwise settings (dial-mark "10"). Tune your receiver to a local station below 800 khz.
2) Raise the POWER-ON switch; reception should improve notably.
3) Try out the LSCA-2 like a regular loop, using only the tuning capacitor and the band-changing switch (pointed upward for stations above 800). It should work well, but not quite as well as the NRC AA loop (which is specifically designed for figure-8, not cardioid, operation).
4) Tune to a station and flick the PATTERN-REVERSE switch back and forth; there should be no noticeable change in reception. Some difference may be noted at the top of the band, indicating that the loop is not perfectly balanced (It's not meant to be).
5) Rotate the LOOP GAIN control; it should vary signal strength. The SENSE GAIN control should do nothing, same with the SHORT-LONG switch. Return the gain controls to their original settings.
6) Detune the loop from the station, then flick the center switch to "CARDIOID". An improved signal should be noted.

Tuning the Cardioid Pattern

1) Repeat Step 1 above; power switch "ON".
2) Find a semi-local station and tune it for best reception in the figure-8 mode (switch still on "COSINE"). The plane of the loop should run in the direction of the station.
2) Flick the center switch to "CARDIOID".
3) Flip the PATTERN-REVERSE switch back and forth. Position the SHORT-LONG switch for the greatest contrast in signal strength on the PR switch, then leave the PR switch on its weaker setting.
4) Carefully rotate the SENSE GAIN control CCW until a dip in signal strength is noted on your receiver's S-meter.
5) Adjust the tuning capacitor. loop bearing (within only a few degrees!), and the SENSE GAIN control again - repeating the procedure - for the best possible null.
6) Reposition the PATTERN-REVERSE switch; the station should now blast in. Return the PR switch to the "null" position.
7) Rotate the LSCA-2 in a full 360° circle; note the cardioid pattern with its single wide null.
8) Flick the PR switch to the "peak" side and rotate the loop again; the cardioid peak and null will be reversed.
9) If you don't get the cardioid pattern the first time, keep trying, using different stations, etc. As a last resort (unlikely), contact the author - by phone only.

Final Notes

The BAX-1 FET amplifier kit is available from International Crystals; 10 North Lee; Oklahoma City, OK 73102. Last quoted price was $3.75 postage paid. The BCB Super-Booster was a project that appeared in a past issue of RADIO-TV EXPERIMENTER magazine; write to them for details.

The total retail price of parts for the LSCA-2 was about $55 in 1975. Expect to pay more, of course, if you hire a fellow DX'er to build it for you. RFS, by the way, is definitely not available for this service.

Certain high-Q loops, such as the NRC AA loop, cannot be converted into a LSCA, so don't even think about it. I say this on behalf of a lot of bitterly disappointed experimenters. The loop used with the LSCA-2 was specifically designed for cardioid operation; the others were not.

Heathkit has a receiver available with a built-in "LSCA". It's the MR-1010, priced at $220!