

Modification of AAA-1 Active Loop Antenna Amplifiers for Resolution of 45 Degrees in Azimuth

AAA-1 amplifier has a crossed loop mode (A+B mode) where the currents of loop A and B are added. If the loops A and B are in one plain (**Fig.1**) as described in the manuals this mode increases the sensitivity and reduce the noise floor which is important for very quiet electromagnetically places. But when the loops are in orthogonal planes **Fig. 2** (rotated at 90 degrees) in A+B mode the pattern is changed and we have an equivalent of a single loop which direction is rotated at +45 degrees compared to A or B directions. If we change only the polarity of one of the loops the direction will be switched to -45 deg.



Fig.1 Loops in one plain

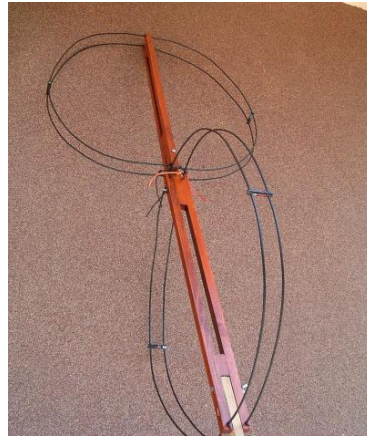
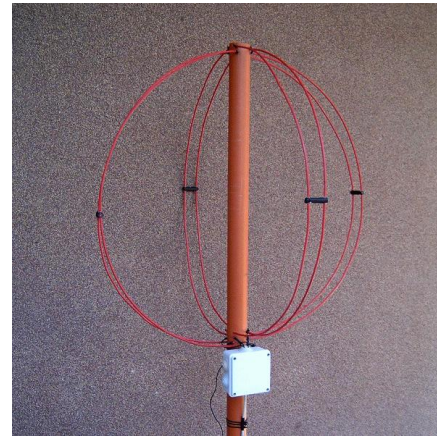


Fig.2 Orthogonal loops



Additional relay is used for this purpose to swap the terminals of loop B (or A) as shown on schematics (**Fig.3**) in order to have +45 or -45 degrees directions. The relay control is performed via free wire in the FTP cable which is not used for other purposes. The relay is 12 v TQ2 type , 10 mA ,(TQ2 Panasonic, AZ850 Zettler, golden plate contacts). If the power supply +V is above 14 V a suitable serial resistor must be added to reduce the voltage. A small board with relay and terminal block is built as shown on **Fig.5**. In AAA-1C models the RJ45 connector is paralleled with terminals for direct wire connections so there is no need to solder the control and +V wires (**Fig.4**) . In Control board four switches are used to control the direction modes as shown on **Fig.4** and **Fig. 7**.

AAA-1, AAA-1B modification for 45 degrees resolution

The wire at pin 5 of RJ45 connector is used to activate the dipole mode in earlier models AAA-1, AAA-1B and these models cannot be modified in the same way. Possible solution is to use wire of pin 3 of RJ45. This wire is a second 0V connection. If we cut J3 (J103 on newer boards) jumper **Fig.8** , (it is factory short circuit on the PCB of Control board) this wire becomes free and can be used in similar way for relay control. On the amplifier side it must not be crimped in RJ connector but connected separately to relay board. +V is available on pin 2 of RJ connector. 0 v activates the relay.

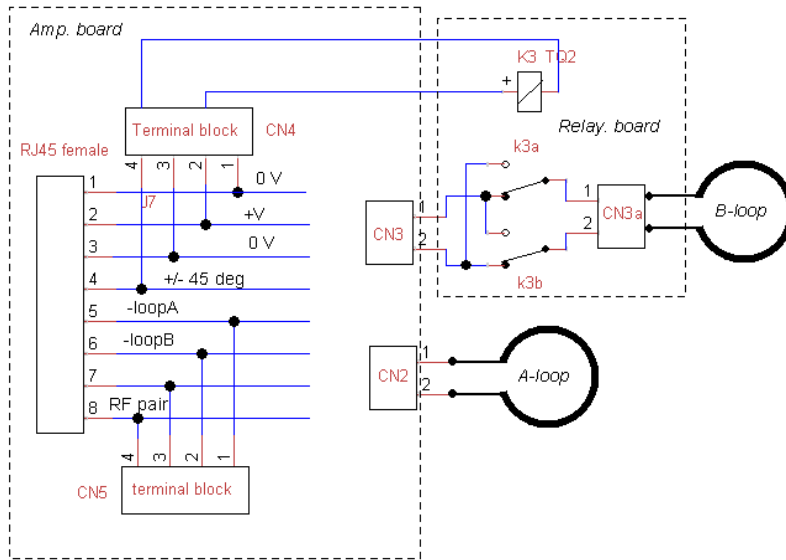


Fig. 3 AAA-1C, D amplifier board modification

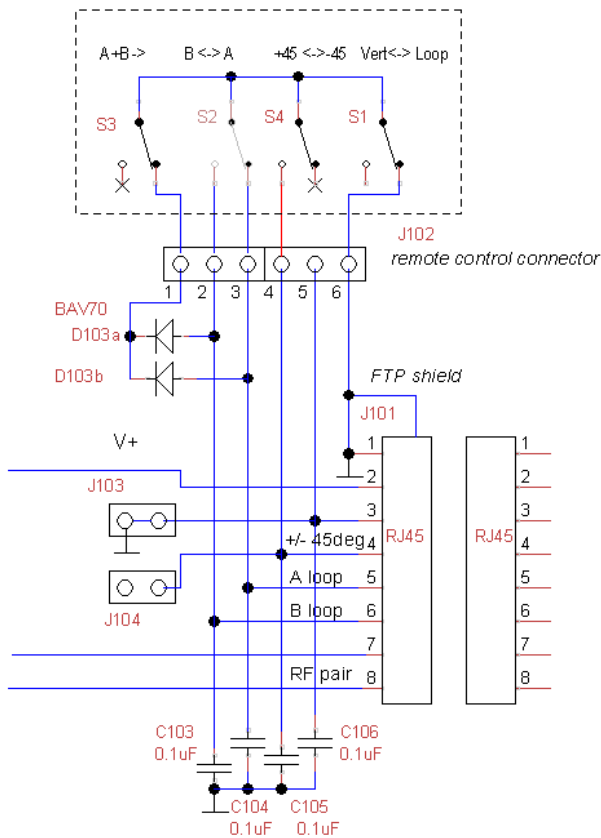


Fig.4 AAA-1C, D Control board switches modifications

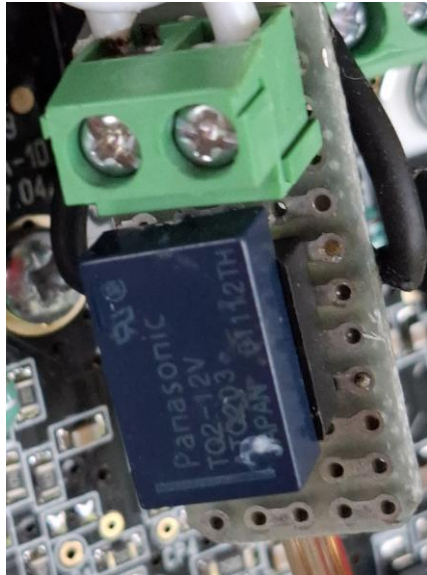


Fig.5 Relay board



Fig.6 Relay board mounting



Fig.7 Mode switches

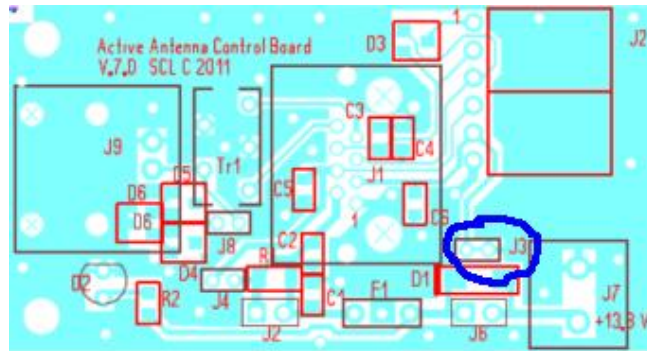


Fig.8 AAA-1, AAA-1B Control board modification

Theory background

A single small loop has radiation pattern as shown on **Fig.9** for vertically polarized waves. By switching two orthogonal loops we will have 90 deg. resolution for azimuth directivity. If we add currents from two orthogonal loops we can rotate the pattern in any direction:

[1] $K * I_a + (1-K) * I_b$ changes direction from 0 to +90 deg.

[2] $K * I_a - (1-K) * I_b$ changes direction from 0 to -90 deg.

Here I_a and I_b are loop currents from two orthogonal loops. K (from 0 to 1) determines the weight of each loop current .

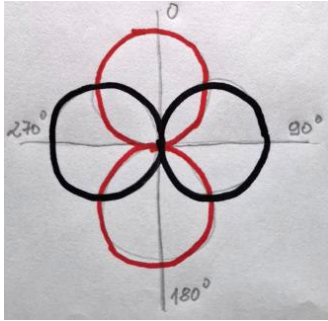


Fig. 9 A and B orthogonal loop patterns

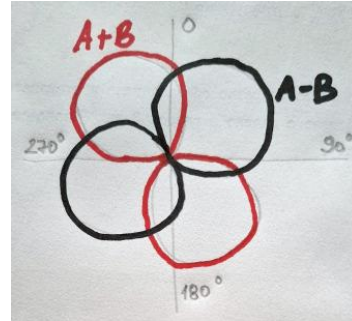


Fig.10 Equal currents patterns of A+B and A-B

Here is an example **Fig. 9, 10** :

For $K = 1$ only Loop A is working. For $K=0$ loop B is working. If $K = 0.5$ loop A and B have equal currents and the direction will be shifted to +45 deg. just between A and B loop directions. We will have -45 deg. direction by changing the polarity of the current from loop B. Any direction (0 to 90 deg.) can be achieved by changing K from 0 to 1. In early days of radio a device called goniometer was used for direction finding which is doing a weighted addition of signals from two orthogonal loops.

It must be pointed out that there is no phase shift between loop A and B currents. For example if a 90 deg. phase shift is introduced for A loop current, the resulting pattern becomes omnidirectional and with circular polarization. A modern approach for arbitrary rotation of loop direction and polarization can be performed with two separate amplifiers for each loop and a two channel coherent SDR with appropriate software.

Comments

Increased resolution is useful especially at lower frequency (for LF/MF listeners) where the polarization is usually vertical. But even at higher frequencies there are cases when the switched directivity is effective. Most common use is to reject the local noise sources (usually vertically polarized) coming from different directions.

Links

1. <https://active-antenna.eu/amplifier-kit/technical-documentation/>
2. <https://active-antenna.eu/application-notes/>