pa0nhc / LZ1AQ small broadband receiving loop antenna. COAXIAL CABLE VERSION.

Construction details. 20200201 English.

Amplifier PCB 20200104-163, splitter PCB 20200104.

For best IMD behavior and common mode suppression :

- Must transistor pairs Q1 / Q2 and Q3 / Q4 be selected for equal Hfe.
- Must C5 and C10 If needed) be ***NP0*** (or C0G) capacitors (selected for equal value)
- Must C1, C4, C3, C11 be ***film*** or Tantalum capacitors.
- Must TR1 be carefully wound and connected.

REM : For long life, the voltage rating of tantalum capacitors should be twice the by the electrical circuit provided voltage.

Warnings :

The following faults in coil construction cause bad amplifier properties :

1. Short circuit between coil wires,
2. Short circuit between coil wires and the ferrite core,
3. Wrong transformer connections.

- The insulation quality and solder ability of lacquered wire differs with supplier.
- The here used cores have no insulation layer.
- The here used cores have sharp edges. Wire insulation is easily damaged.
- Ferrite mix #77 and #31 is conducting.

I recommend using *solder able lacquered wire*, available at : (www.koperdraad.nl).

Measures against short circuit in coils :

BEFORE coil winding, put two layers transparent nail lacquer “Top Coat” on the ends of each core. Let harden firmly.

Important winding suggestions :

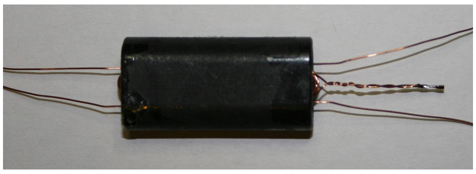
- Wind close to the core.
- Every next turn should be beside the former turn.
- Do NOT wind backwards, always in the same direction.
- A turn may not run over, nor under another turn.
- Divide all turns evenly over abt. 300 degr. core circumference.

AFTER WINDING, MEASURE THE UNSULATION REISTANCE BETWEEN WINDINGS AND WINDINGS AND CORE.

Preparing the twisted wire bundles for CMC1 and Tr1.

- Cut two 0.25mm lacquered wires. Wire length = ((number of turns x 5) + 30) cm.
- Twist one end firmly, and fold it double.
- Clamp this end in a vice.
- Keep both wires parallel and stretched.
- Twist the free end firmly, and fold it double.
- Clamp it in the chuck of an electric hand drill.
- Keep the drilling machine in line with the wire.
- Keep the wires stretched while twisting. Prevent wire kinks.
- Twist the wires firmly for 2 full turns per cm.

CMC1,L4,L30,Tr1 and Tr30.



Transformer Tr1 is wound with 0.25mm lacquered wire onto a long FairRite **mix 61** two-hole ferrite core (“pigs nose”).

One turn = *gone once through both holes*.
1. Wind the the primary with 8 turns two ***twisted*** wires.
2. Twist the **end** of one half, with the **beginning** of the *other* half. ***Be sure, measure it.***
   At 1cm distance form the core, solder both wires together (400C). Do not shorten wires yet.
3. Wind the secondary with 4 turns. Start at the opposite side from the primary (see PCB top).

Transformer Tr30 is also wound onto a long FairRite **mix 61** two-hole ferrite core. Each winding with one 0.25mm lacquered wire.
Start winding the primary with 12 turns.
Then start at the opposite side winding the 12 turns of the secondary.

– **CMC1** is wound with **two twisted** 0.25mm lacquered wires **20** times through the hole of a 13mm #31 core.

– **L4 and L31** are each also wound **20** times through the hole of a 13mm #31 core, but with **one** 0.5mm (0.25mm) lacquered wire.

After winding, pre-tin all wire ends with a solder iron temp. of 400C. First remove a little wire insulation for easier solder flow. This enables you to measure core and wire insulation, and corresponding winding ends.

– ***Now FIRST check wire and core insulation, with an ohm meter range of 2 Mohm.***

Connecting coils.

CHECK solder flow to prevent a difficult fault search later on.
Keep wire pars of CMC1 well twisted right onto the PCB holes.
Keep every wire end between the ferrite core and the PCB as short as possible.
– Feed the wire ends in the correct holes.
– Using a sharp knife, remove a little insulation from the wire very near the hole.
– While making good contact with the wire, pre-heat wire and PCB hole for abt. 6 sec. at 400C.
– Add a little solder.
– Keep heating for 6 sec. *until the solder is flown into the hole and firmly flown onto the wire*.
  Inspect this visually AND by measuring it !

Glue finished coils onto the PCB using water resist glue (Bison Kit Transparent).

Testing.

– Leave the antenna inputs unconnected.
– Connect the amplifier output directly with the splitter input.
– Connect the splitter with the receiver and a noise free 12Vdc power supply.
If the values below differ to much from your measurements, then FIRST repair the cause of the fault.

Measure :
– **Total current consumption : abt. 132 mA.**
– Vr1 input : >= 11,5 Vdc.
– Vr1 output : 10,0 Vdc / +- 0.1 Vdc.
– C6 : 9,7 Vdc +- 0.1 Vdc

– **R1 and R2 : abt. 1,4 Vdc.**
– The *difference* between R1 and R2. Allowed diference is max. 10 **m**Vdc.
  If larger, replace Q3 and Q4 by transistors with equal Hfe.
– **R6 and R15 : abt. 3,65 Vdc**
– The *difference* between R6 and R15. Allowed difference is max. 20 **m**Vdc.
  If larger, replace Q1 and Q2 by transistors with equal Hfe.
– **R9 and R19** *on all ends* : **9,7Vdc** +-0,2Vdc.

TIP : if one side measures abt. 4Vdc, Tr1 is not connected correctly.

Checking the amplifier noise floor.

The noise levels below are an indication for good operation.

– Leave antenna connections open.
– C5/10 are NOT installed.
– Software : **SDRconsole, Att = 0, Visual Gain = +30dB, Mode = AM, Filter = 3 kHz.**
– 50 kHz : -110 dBm
– 10 MHz : -110 dBm
– 20 MHz : -118 dBm
– 30 MHz : -121 dBm

The cabinets.

Screening <u>metallic</u> cabinets for amplifier and splitter are <u>*absolutely*</u> needed.
They prevent “PIN1 problems and cable Common Mode noise import.

All BNC and N coax buses <u>*MUST*</u> be installed having good electrical contact with the <u>*outside*</u> of the cabinets. Remove any insulating paint.
They prevent “PIN1 problems and cable Common Mode noise import.

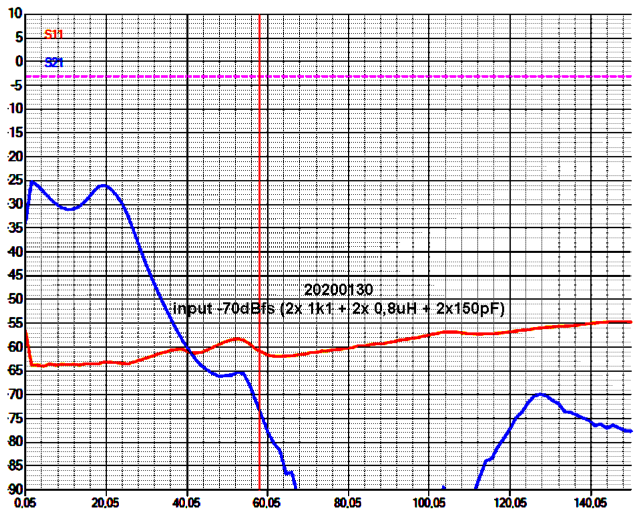
<u>*Screening*</u> the loop is absolutely necessary.

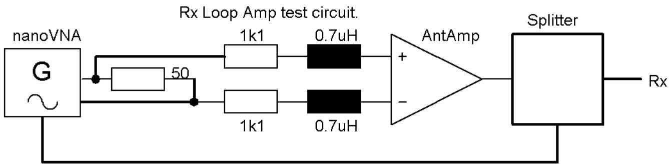
It prevents reception of E-fields, and **<u>*coupling with transmission line common mode*</u>**.
Together with the use of screening metal cabinets it has a big influence on noise levels.

A screened loop can simply be made from a piece of coaxial cable. In the exact midpoint of it, do remove abt. 1cm of the screening bread. First put a little Vaseline over the edges of the remaining screen, and insulate it with crimp hose. Check for good insulation and connection. Install and waterproof both N-connectors and the N-buses with Vaseline.

Loop capacitance.

To prevent overload from very strong local FM broadcast stations, the amplifier antenna input circuit contains balanced low pass filters which attenuate all signals above 30 MHz.
<u>The amplifier input circuit is designed for a total loop capacitance of 2x 120pF to 2x 150pF.</u>
If the coax capacitance of the loop is less than 2x120pF, C5 and C10 on the amplifier PCB must be installed to compensate for the to small loop capacitance. Their value : 120pF - “calculated capacitance of a half loop”.



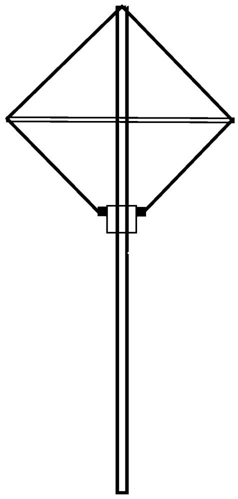


If RG213 cable (96 pF/m) is used to construct this screened loop, the *maximal loop circumference* is 3.13m. It should be bend into a circle.

If thin RG316 PTFE coax (106 pF/M) is used, the *maximal loop circumference* is 2.8m.

The supporting cross.

The loop can be installed onto a 50mm (or 42mm) PVC pipe mast, and a horizontally supporting 22mm PVC pipe.
The amplifier box can be fixed onto the mast using accompanying 50/42mm PVC saddles.
Using a 25kg concrete filled umbrella foot as antenna base, this antenna needs no guy wires.



A thin RG316 coax loop can simply be configured as a square. It can loosely be fed through 4mm holes in the PVC pipes. At these places the coax outer skin could be protected by crimp hose against outer insulation damage and water intrusion. The loop can be straightened by lowering the antenna box and locking the box in place.

The coax feeder.

If a short (<= 10m) coax feeder is to be used, use very thin RG316 PTFE coax.
It is nearly invisible, and allows to construct *very* good common mode chokes.

For longer feeder lengths use a thin version (4,8mm) of RG58 coax. It enables less turns in a CMC, which then have less performance.

Why Common Mode Chokes (CMC's) could be needed on feeders.

½ lambda long feeders cause common mode currents and should be avoided. **See articles by K9YC.** In receiving systems, they result in higher noise levels at certain related frequencies.
A 20m long feeder shows ½ lambda resonances at multiples of (20m/2) wave length :
10m, 20m, 30m, 40m etc.
A 15m long feeder shows ½ lambda resonances at multiples of (15m/2) wavelength :
7,5m, 15m, 22,5m, 30m etc.
The possible noise hinder depends on the feeder length, and on the used frequency band.

My results after installing CMC's.

This loop antenna is tested and further developed in my *very* noisy location. The nett length of the coax cable is abt. 25m. It runs through my whole house, and over the roof surface of the neighbors below. Floors and roofs contain very noisy mains power cable. 9 CMC's were installed at distance of abt. 3m.
Result : When the antenna power supply is *switched-off* , all very strong noises and signals at frequencies lower than 1.6 MHz become 40 dB to 65 dB (!!) weaker. Above 1.6 MHz most signals are less strong, and nearly no noise nor signals are detectable with antenna power-off.
This is a proof of pure *differential mode behavior* of the connecting coax cable,

and the electronics. The coax acts as a pure balanced line. **This antenna is NOT grounded, but practically only receives by its loop, NOT by its feeder.**

Do *you* need CMC's ?

Check the difference in signal levels, when the antenna is powered-off. If you see to little difference, common mode signals on the feeder possibly do influence the performance of your screened loop antenna system.

Then try installing CMC's on the coax feeder :

- Begin with a CMC directly at the antenna box, and another CMC directly at the splitter box.
- Install CMC's in between with distances of maximal 4m.

A good CMC for this project contains a maximal possible number of coax turns through the 18.5 mm hole of a 29mm x 42mm **#31 ferrite** split core (FiarRite “SnapIt” **04 31 17 35 51**).

2,5 mm coax : 11 turns (2m). Zmax >= **4.8 *kOhm.*** =======>>
5 mm coax : 8 turns (1,5m). Zmax only >= 2.6 kOhm.

REM : After winding, the coax should fit *loosely* in the core hole, and both ferrite halves should close perfectly in contact to each other.

CMC wound with RG316 coax.

REM : with an E-field antenna like the **Miniwhip**, screening of the antenna electronics is impossible. The appropriate de-noising measures for an E-field antenna are :

1. **grounding the antenna PCB**,
2. Install every 3m CMC's on the coax transmission line,
3. Connect the BNC buses at the splitter box onto its outside surface.