

LZ1AQ Loop Antennae for NDB DXing

Part 1 - Antennae, Signal Sources, Measurement Scheme, Summary of Results

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1. Antennae Under Test:

	Antenna	Construction	L (uH)	R (Ohms)	Area (ft ²)
Rotatable Loops					
1	4 Ft One-turn 4 ft Loop	1/2" Al Tubing	3.6	0.0130	12.6
2	4 Ft Two-turn Parallel Connected Loop †	#8 Wire	2.5	0.087	25.1
3	4 Ft Two-turn Cross-coupled Parallel Loops †				
	Square Wire Version	#14 Wire	3.1	0.024	25.1
	(Tube Version)	1/2" Al Tubing	1.9	0.087	25.1
4	LZ1AQ One Turn 8 ft Loop	3/8 " Al Tubing	8.6	<0.1	50.3
Fixed Orientation Antennae					
5	Pair of 3 Meter Orthogonal Square				
	Loop #1	#14 Wire	17.9	0.107	96.8
	Loop #2	#14 Wire	18.6	0.110	96.8
6	20 x 10 Ft Rectangular	#14 Wire	27.1	0.15	200
Exact duplicate versions of #2, #4, and #6 were also available for test at secondary QTH in Tennessee.					
† Current-adding connection					
AWG #8 multi-strand Copper Wire Diameter = 0.1285 in / 3.264 mm, 0.622 ohms/1000 ft					
AWG #14 multi-strand Copper Wire: Diameter = 0.0641 in / 1.628 mm, 2.525 ohms/1000 ft					

2. Signal Sources:

NDB	kHz	QTH	Power (W) †	Miles	Azimuth †	Monitoring Frequencies (kHz)		
						Carrier	Noise 1	Noise 2
RNB	363	Millville NJ	37 (?)	59	213°	363.047	362.847	363.147
TT	369	Trenton NJ/PA	25	20	287°	369.049	368.933	369.643
NEL	396	Lakehurst NJ	75	12	119°	396.106	395.994	396.281
† Power (nominal) as listed in WWSU V6.4.11								
† Azimuth directed from my Cream Ridge NJ QTH at 40 07 49.7 N 74 32 06.56 W (true), FN20rd.								

3. Measurement Scheme:

In its essentials the measurement scheme used here was a relative one ... the gain and noise floor of each of the LZ1AQ antennae was compared with that of the well-regarded Wellbrook ALA 1530 wide band loop antenna. All measurements were made on the carrier with the data for the loop under study and the reference loop accumulated consecutively.

For each of the three NDBs, at least nine independent measurements were made at approximately three hour intervals for at least three consecutive days on at least three separate sessions. The times chosen were centered on local noon to minimize sky-wave effects.

- (a) For the rotatable loops, the LZ1AQ loop and the Wellbrook ALA1530 reference loop were oriented to give maximum signal, i.e. plane of loop lying along the azimuth from the QTH to the NDB. This orientation was set to be orthogonal to the loop's null. All of these loops have sharp nulls which affords this to be an excellent scheme to attain a quite reproducible antenna orientation. For the Fixed Orientation Antennae, The ALA1530 reference was aligned (via compass) parallel to the antenna under test.
- (b) The Noise Floor was measured at two frequencies, "Noise 1" below the carrier frequency and "Noise 2" above the carrier frequency. The frequencies were chosen to be clear of any interfering signal which might possibly contribute to the noise floor. Occasionally local conditions caused these frequencies to be changed from the values cited above. For the Signal/Noise calculations, the two noise floor readings were averaged.
- (c) Except where noted, the same preamp (Mark VII) was used in both NJ and TN for all of the various LZ1AQ loop configurations.
- (d) Except where noted, signal strength was measured using the S-meter of a Perseus SDR receiver running under the control of the native Microtelecom software. The receiver was in the S-meter "rms mode", all other settings, e.g. Preamp, Attenuator, Dither, Noise Blanker, etc. were "off" except "Sampling Rate" which was set to 1000 kS/s.

4. Summary of Results

Table 1 - LZ1AQ Loop Antennae - Data Summary – Bandwidth 10 Hz							
Averaged data for NEL_396 Lakehurst, NJ is shown.							
	L(uH)	Null (dB)	Signal (Avg dBm)	Noise (Avg dBm)	S/N Ratio	Aperture (sq ft)	Avg Δ(S/N)
Rotatable Loops							
4 Ft One-turn Loop (1/2" tubing)	3.6	>32	-73.2 ± 0.4	-114.9 ± 3.3	41.7 ± 3.4	12.6	-4.1
4 Ft Two-turn Parallel Loops (#8 wire)	2.5	Unchanged when antenna turned 180°	-67.0 ± 0.1	-114.1 ± 2.5	47.1 ± 2.5	50.4	-1.9
4 Ft Two-turn Cross-coupled Parallel Loops							
Square Wire Version (#14 wire)	3.1		-76.7 ± 2.1	-114.5 ± 3.4	37.8 ± 4.4	50.4	-3.6
(Tube Version)	1.4		Data discarded – loop inductance too low				
8 Ft One-turn Loop (3/8" tubing)	8.6		-67.0 ± 0.4	-115.3 ± 1.2	48.3 ± 1.3	100.5	+2.2
Fixed Orientation Loops							
Pair of 3 Meter Orthogonal Square (#14 wire)							
Loop #1	17.9	~43 ‡ (Loop Data Combined)	Orientation too close (16°) to null position			96.8	+13.9
Loop #2	18.6		-69.6 ± 0.5 ‡	-119.5 ± 1.3 ‡	49.9 ± 2.4		
60 Ft Circum Rectangular (#14 wire) †	27.1	-	-72.0 ± 0.1	-118.6 ± 0.8	36.6	200	+2.9
Δ = S/N difference: LZ1AQ - ALA1530; average of the S/N for all three NDBs used as signal sources. ‡ = Corrected for Loop #2 being 16° off azimuth to NEL_396. † = Uncorrected data – see antenna's Data Sheet.							

This table is a compilation of the data required to estimate the signal-to-noise ratio of three local NDBs used as test signal sources. Since the data for the three NDBs were found to closely parallel each other, for simplicity in presentation the data for only one of the NDBs (NEL_396) are shown above. The sole exception is for the entries in the Δ(S/N) column which are averaged over all three test signal NDBs. See the individual antenna data sheets in later parts of this report for further information.

The signal and noise-floor data listed for each antenna are the average of three values recorded midday each day for at least three consecutive days during three separate sessions.. The estimated error shown is the standard deviation of (at least) 27 measurements. The Std Dev is listed as the "±" quantity in some tables and, following the usual practice, is taken as an estimate of the experimental error for the reported data entry.

Coincident with the LZ1AQ antenna measurements, identical measurements were made on the well-regarded Wellbrook ALA1530 ALA1530 in use as a reference antenna. The algebraic difference in the average S/N ratio of the LZ1AQ loop and the ALA 1530 loop are offered as a measure of the "quality factor" of Chavdar's design [see Δ(S/N) in table above].

Table 2 - Reference Loop – Wellbrook ALA1530 Loop							
10 Hz Bandwidth							
	L(uH)	Null (dBm)	Signal (Avg dBm)	Noise (Avg dBm)	S/N Ratio	Aperture (sq ft)	Δ
Wellbrook ALA 1530 Loop	-	~42	-71.3 ± 0.2	-113.6 ± 2.0	42.3 ± 2.2	12.6	-

The data in Table 2 report the average noise floor at my NJ QTH over the period 28 Apr – 16 Jun 2015 and is an average over a total of 486 measurements. This data is presented only as general information and is not used in any calculation of Δ(S/N). [Incidentally, the ± 2.0 dB 'error' estimate in the ALA1530's noise floor is an excellent measure of the variation in daytime QRN in Central NJ over this period.]