Some impressions and an attempt to do a field test:

K9AY

DXN **Bjarne Mjelde**

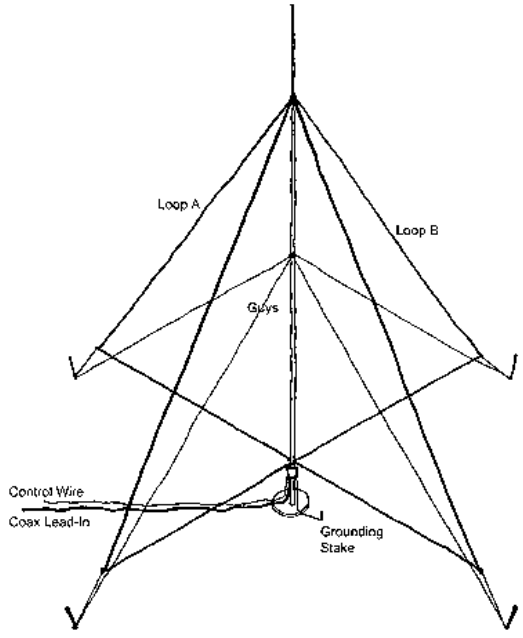
Bjarne Mjelde har skrevet denne artikkelen etter å ha testet K9AY loop-antennen som er blitt ganske populær i DX-kretser den siste tiden. Artikkelen er skrevet på engelsk og vi lar den være på engelsk for en gangs skyld.

Introduction

The K9AY loop is with little doubt the ”hottest” DX gadget among serious DX-ers today. The Wellbrook K9AY has been widely acclaimed by many DX-ers, and several articles have been written about it, among others by Guy Atkins and John Bryant. Having seen evidence of brilliant performance despite its size, I felt tempted to buy one of these new toys.

A brief introduction for those not familiar with the Wellbrook Communications K9AY loop:

The antenna uses two, or four, delta-shaped loops to provide a steerable cardioid pattern in 90° or 45° steps.



A remote controlled variable termination allows the user to optimise the null during changes in the arrival angle of interfering signals, and provides a considerable improvement in reception quality. The K9AY comprises of an Antenna control unit and two Antenna head units. A 10-15dB broadband amplifier is selected by a front panel switch on the control unit. In addition, the control unit consists of a direction switch (8 directions, 4 directions for the 2-loop version, with an option to expand to four loops), an Omni switch to select all loops, and a nulling control.

It is recommended that the loop be erected using a seven meter high vertical support, with the horizontal base of the loop equal to five meters per side.

Down to the left is John Bryant’s 3D impression of a 2-loop K9AY.

My loop was made by Wellbrook Communications. Because I live only 4.5 km from a 250kW Loran C station on 100 kHz, I asked that the circuit be made especially to meet the challenge from this extremely noisy RF source. I ordered the vertical support from Germany; the radio amateur DK9SQ Walter Spieth manufactures a black fiberglass mast 10 meters high that is just about perfect for this. My loop was made with a height of 8.5 meters, width 5 meters, grounded with a single copper pipe and counterpoises under each loop. The distance to the nearest building (and RF source) is some 30 meters. The coaxes run some 50 meters each (they had to round corners ☺)

After some trial and error during the setting up of the loop, I finally made it stand rather perfectly vertical. I used guys at 1 meters and 6 meters. In addition, the loops themselves are fastened in a way that brings additional support to the mast. I think it is fairly solid and it has survived its first gale. The truth will emerge with the autumn and winter storms.

The shack

The equipment used for testing and comparison were the following:

The Kneisner & Döring KWZ-30 receiver, which has a broadband front end. This excellent receiver has one feature not found on other receivers in its price segment – a very accurate field effect digital readout in addition to the usual S-meter. Thus I'm able to detect differences in signal levels not measurable when using an S-meter.

A 200-meter bidirectional beverage. It is directed towards ENE-WSW and is very efficient with signals originating from Asia and Western Europe/South America.

The K9AY loop

A broadband ultra-linear combined 2-way splitter/preamplifier/wave trap made by Stefan Wikander of Sweden.

A broadband ultra-linear combined 4-way splitter/preamplifier made by Wellbrook Communications.

Coffee!

Comparison – benefits and drawbacks

The beverage has a distinct front and back lobe, while it attenuates signals from the sides quite well. Of course, the lobes are not consistent throughout the MW spectrum, as its 1-wavelength lobe at 1500 kHz is considerably sharper than its ½-wavelength lobe at 750 kHz. Since the K9AY has consistent lobes, this requires that comparisons be made with that in mind.

Because of the beverage's lobe properties, any comparison between that and the K9AY has to be done with stations being within the beverage's front or back lobes. Comparing the K9AY with the beverage in the latter's side null would be nonsense.

Of course one should have had 3 or 4 beverages to compare with. Since that is not the case, we can only make the best of it.

All comparisons are made with the loop's amplifier ON, unless stated otherwise.

For those not familiar with how signal strengh in dBm is related to the usual S-meter readings: Approx. 6dB is one S-unit. The following table may serve as a guide:

S-units	Field effect
S-9+30	-43dBm
S-9	-73dBm
S-5	-98dBm
S-1	-123dBm
S-0	-130dBm

Values are rounded to the nearest full number. The subject of bringing in the S-0 level is intriguing. But after all, a fully readable signal usually requires a S+N/N ratio of at least 20dB. So how does one explain a fully readable signal at –118dBm? Read further.

Signal Pattern

It has been said that the K9AY has a uniform nearly 270-degree main lobe, and a sharp, V-shaped back null. Mark Connelly once described it as "heart-shaped". This may be true for the 2-loop K9AY, but the 4-loop K9AY seems to have a different signal pattern. It has been suggested (among others on the K9AY Internet discussion list) that the K9AY's azimuth is similar to that of a ½-wavelength beverage antenna. Based on the results in the following, I'd rather say it has an azimuth closer to that of a 1-wavelength – or even a 1 ½ wavelength - beverage (as illustrated in Misek's "The Beverage Antenna Handbook", 2nd edition, pp. 9 & 11).

Nulls are present not only in the back of the loop, but on the sides too. The table below shows the signal levels of daytime signals from NRK Vadsø 702 and Radio Rossii Murmansk 657 when using the null control to minimise signal level:

Direction	NRK Vadsø 702	RR Murmansk 657
North	-98dBm	-100dBm
North-East	-95dBm	-103dBm
East	-80dBm	-84dBm
South-East	**-75dBm**	**-80dBm**
South	-77dBm	-84dBm
South-West	-84dBm	-95dBm
West	-90dBm	-98dBm
North-West	-103dBm*	-110dBm

*** However at one instant I was able to null 702 by a whopping 47dB**

This not only shows that one can null a signal on the 90° and 135° sides of the loop (in

addition to the 180° null), but it seems to confirm a finding made at a Grayland, WA DX-pedition, namely that the loop has a distinct and relatively sharp front lobe that is more sensitive than settings 45° away. The South-East position (in bold) is the approximate bearing of the stations. We see that 45° away, the signal is 3-5dB weaker. This is not a substantial amount I admit, but nevertheless quite interesting. The difference in gain seems to increase with wavelength, as tests on stations below 600 kHz suggested even greater differences. Above 1300 kHz the difference is difficult to measure. So, does the loop has consistent lobes as stated under ”Comparison - …”? Evidently not! It seems to have a narrower lobe with increasing wavelength, contrary to the beverage which has a narrower lobe with decreasing wavelength.

The table seems to suggest that using the nulling control, the loop has a 90° (or possibly even <90°) front lobe, approximate nulls of 15-20dB at 90°, approximate nulls of >20dB at 135°, and nulls >25dB at 180°. In other words, nulling increases with angle from the loop's plane. However, when nulling at 90° off the bearing with the null pot adjusted to near or fully anti-clockwise to give the Vactrol resistance of say 100 Ohms, the loop has a distorted figure of 8 pattern and a poor F/B ratio. This pot adjusted should be avoided unless the source of interference is at 90° and the F/B ratio is of less concern. This according to Andy Ikin.

The null levels 90° away from the bearing are not uniform, as one would expect them to be. This could be because the bearing of the stations is not exactly aligned with the plane of the loops, and that the side null is rather sharp. To find the antenna's exact azimuth one would have to place it on a rotor and measure every few deg. The coarse 45-degree steps are insufficient in finding exact null values or any ”hidden” side/back lobes (except if using mean values of a large number of stations covering all directions. That project would be to ambitious for me to enter).

Noise

The K9AY, it is claimed, is as silent as a T2FD, and more silent than an ordinary longwire. To find out about this, I first measured the signal reading of the KWZ-30 with no antenna load. This read as –123dBm. I then connected the beverage on an empty frequency (1500 kHz) at daylight. The readout was –122dBm. When I connected the K9AY, the readout varied between –119 and –120dBm on the eight directions. Considering that the 10-15dB amp was on, this is truly excellent.

With the amplifier off, it was down to –123dBm. In comparison, the beverage connected to Wikander's preamp gave a readout of around –116dBm.

Another aspect of the noise problem is the Loran C. Some of the readers may be informed about what this 260-meter high tower, equipped with a 250kW transmitter, operating on 100 kHz only 4.5 km away does to my beverage antennas. The only remedy that partially cures the pain is a wave-trap designed for attenuating signals on 100 and 200 kHz. Several attempts to make highpass filters to attenuate signals below 500 kHz have fallen short. The noise makes DX impossible in the 550-590 kHz range, and is a major disturbance to DX between 890 and 1100 kHz. On other frequencies it is just a pain in the as – sorry, neck. I have noticed that the noise level increases with the length of the antenna. Hence, I had hopes that the short wires of the K9AY could have a positive effect on the Loran C noise. A test of the Wellbrook ALA 100 loop (16-meter circumference) in 1999 proved that this could indeed be the case.

And it did. Certainly, the Loran C is notice-able on the frequency ranges mentioned above. However, the noise level is significantly lower than with the beverage. Moreover, it is possible to null the noise completely with some of the direction settings. That alone nearly justified the cost and labour with the K9AY. A test with the Iceland 189 kHz station comes to mind; with the beverage one could barely hear that there was ”something” behind the noise. With the loop, Iceland was totally in the clear with practically no noise.

Signal level

Local or semi-local daytime signals are roughly equal level on the loop and the beverage on the lower part of MW, slightly higher advantage loop on the higher part. Now, since local MW stations aren't the reason why I bought the K9AY, I did a sunset/post-sunset comparison with long-distance signals (mainly from Japan, China, Taiwan and The Philippines). Comparison was difficult because the beverage signals fluctuated as much as 10dB while the loop signals were extremely stable. Conditions were generally poor, with an A-index of 16 and unsettled/minor storm geomagnetic levels. Generally, the beverage had a 1-4 dB higher signal level on the middle and higher parts of the

MW band, while on the lower part the difference was around 6-10dB or roughly 1 S-unit.

Comparing a (although modest length) beverage directed at its main target, and observing the K9AY playing practically at the same level was most rewarding. Of course, one should expect that the difference in signal level would increase with the length of the beverage, and that e.g. a 1000 meter beverage would outperform the K9AY by a solid margin. Will all owners of an array of 1000 meter beverages please stand up ☺

Grayland

A difference in signal levels by 1-3dB is, when using one's ears, nothing. I was unable to detect any differences in audio that would suggest that the two antennas performed differently. Had I not had the measuring equipment to help me, my conclusion would have been that there was no difference at all.

Other users (such as participants to the Newfoundland and Grayland DX-peditions) have reported that a beverage directed to a specific area will perform better than the K9AY for stations from that area. This corresponds with my experience, but will not play a major role until the beverage reaches a length well above 200 meters. However, a long beverage with a narrow lobe will leave areas uncovered. Unless one has a large beverage array (such as Lemmenjoki, Finland), the K9AY will do very nicely in "filling the gaps", so to speak.

There is of course one other advantage with the beverage, as a two-three beverage array towards one area (like North America for a European DX-er) will have the ability to separate stations from different parts of the continent,while the K9AY will tend to hear all parts at once. Possible result: Fewer stations to reach a readable level than with the beverages.

Will the K9AY permit further amplification? During winter days here in the Arctic, signal levels are often low, and beverage antennas are often amplified to let that rare DX come through. As far as I can tell, the K9AY can stand another 10dB amplification in the form of an excellent quality preamp without problems, provided that signal levels in general are on the low side. Intermod. from the Loran C appears very quickly if linearity is compromised; connecting the Wikander 10dB preamp to the K9AY did not cause any intermodulation problems.

There is however a general rule that signal level not be increased unless it is necessary. One should comply with that. For all I know, K9AY users in RF-plagued parts of the world, such as Central Europe or North America, may be best served by having the amp switched off altogether.

The ultimate test, as I see it, would be the K9AY's sensitivity in a low-noise, ultra-low signal level environment, as one often experiences during winter days here in the Arctic. I had a chance to find out as the geomagnetic field finally settled to "quiet" with an A-index of 5. This would enable loggings of North American stations.

I pulled myself out of bed just at sunrise, to discover that there were weak East Coast signals on frequencies like 1520, 1500, 1200, 1150, 950 and some others. I first used the loop with the KWZ-30 and the beverage with the AR7030+, and then swapped receivers since the AOR is slightly more sensitive than the KWZ-30.

The noise level was so low that I could actually hear stations with 100% readability at a –118dBm signal level. No European interference was present on the frequencies I checked. I was very surprised to learn that the K9AY played at equal terms with the beverage on all frequencies down to around 900 kHz. Below that the K9AY was less sensitive than the beverage, but still only marginally so. In fact, since I could null the Loran C so effectively, readability was on several occasions <u>better</u> than

with the beverage. The stations were audible (though still at a very low signal level) well past sunrise.

When connected to the AR7030+, I could use the internal preamp in addition to that of the loop without any problems. Readability improved greatly.

True enough, the beverage is not optimised for ECNA reception with its direction somewhat to the South of the continent. But it was the best ECNA performer in my previous 2-beverage array towards North America, so I feel that the comparison was pretty fair.

In many instances, it pays off to use the "Omni" setting when directivity and nulling is of minor importance. I have found that the general signal level is somewhat higher with the "Omni" setting – sometimes only 2-3dB but sometimes as much as 6-8dB. In a low signal level environment with little or no interference, the extra gain will be most welcome.

Nulling

Wellbrook Communications claims nulls of typically 20dB, with up to 40dB nulls in some cases. From what I have learned, a proper ground system is critical for this to take place. This is a problem here where the ground is generally rocky and/or stony beneath a 10-20 cm thin layer of soil. My original ground rod was 40cm deep, certainly inferior to the 1-1.5 meter rods into moist clay that I've heard some have.

On daytime signals from local stations, I was first able to null around 20dB. This didn't seem satisfactory, so I recalled an article written by Nick Hall-Patch some years ago about using salt water to enhance short ground rod's grounding abilities. This seemed to help, as I did null the local NRK by 32dB (and later up to 47dB) at daytime. However nulls were less profound during darkness.

In general, I am able to obtain nulls in the 10-20dB region on skywave signals and 20-35dB on local/semilocal signals. This is good, but you need to work on the grounding systems to maintain this level. I have heard other K9AY owners having a problem with nulling, and I suspect that insufficient grounding may be the problem. I modified the ground somewhat by introducing another rod, and connected the counterpoises and ground lead to the head unit for two loops onto each rod. I also interconnected the counterpoises at the far end. Anything better than this is hard to get. It remains to test the Bentonite solution suggested on Hard-Core DX.

Unlike a phasing system, when you have obtained a null from a station in a specific direction, the null is consistent over a large bandwidth. This means that you don't have to retune the loop when you move to another frequency, given that interference comes from roughly the same direction.

Scan the MW band with the null on and the noise level on every frequency is like if you switched on an attenuator. Compared to an antenna phasing system, nulling on the K9AY is much less time consuming. One could say, it is like phasing without "foreplay"!

I have also fed two receivers with output from the K9AY via splitters. I tested two different active splitters with this setup, and there was no noticeable difference from using only one receiver.

Phasing

Phasing? With a K9AY loop? Well yes, actually. The Wellbrook K9AY has an Omni switch to select all loops instead of only one. I thought that in its Omni mode the K9AY should behave rather like a vertical antenna, such as an Inverted-L. To test this "theory" I connected the K9AY and the beverage to a Wellbrook APU-100 antenna phaser. And it worked! I nulled the local NRK 702 by >40dB easily, and had nulls of 10-30dB on several other frequencies.

Since a phaser (like the APU100 or the more widely spread MFJ1025/1026) is not only capable of nulling, but enhancing as well, I also achieved considerable gain increase on many frequencies. I used the AR7030+ for this test so I have no exact numbers except the general term: It works! The most stunning example was eliminating the semi-local NRK-702 kHz to bring a clear signal from Iran…OK so conditions were extremely auroral at the time but still!

One may ask why one would use an expensive antenna like the K9AY as a noise antenna with a phaser, when one can be perfectly well covered with a simple design like an Inverted-L. That is not really the question. It simply adds versatility to the K9AY and reduces the need for putting up more antennas. On the other hand, adding boxes like the K9AY control unit, the phaser control, preamps, antenna

switches etc. really messes up your radio shack. Or so my spouse says.

Shortwave

To be honest, I don't tune the SW bands very much, except for the odd newscast from BBC World Service. Compared to the beverage again, the signal level is very much higher – so high that one should switch off the amplifier. I have detected mild directionality on SW up to the 49 meter band – propagation has left the lower bands empty so there was really nothing much to test. For most purposes the K9AY is excellent for SWL and probably for DX-ing too, except it's lack of directionality may give more noise than a beverage antenna directed at a specific area. John Bryant has an extensive discussion on this topic.

The support

A few words if you consider setting up the loop with a fiberglass mast:

The DK9SQ mast have a tendency of de-telescoping if too much load is applied. This may happen with the combination of four loops, guys and heavy wind. It is recommended to use strong tape or hose clamps to fasten the telescope elements. Alternatively, one can go for the fiberglass mast from Von der Ley Kunststofftechnik in Germany; the elements are locked mechanically instead of having to rely on friction alone. Alas, the mast is considerably more expensive than DK9SQ's mast.

Conclusions

This is without doubt THE antenna for those who want to do serious MW DX-ing and do not have the space to erect multiple long beverage antennas. It will null local or semi-local stations quite effectively, probably far more than any beverage can do, and with an ability to steer the null as well. Its gain makes it very effective for any kind of DX – be it nighttime, greyline or daytime.

It is expensive – currently the standard two-loop version runs at GBP 165, the four-loop version is GBP 200 and the four-loop with the special Control box with the 8 way direction switch will set you back GBP 240. These prices do not include postage, which is charged at GBP 5 for the UK and GBP 15 for overseas. You also need to cash out for wires, coaxes and a vertical support (unless you have a nice-fitting tree). But expense is a relative term. It is expensive compared to the random longwire, or one or two beverages, but compared to many active antennas that are commercially available, it's really cheap. The price/performance ratio is truly excellent. And compared to the GBP 1000+ receivers we love to buy, and considering that the antenna system is the truly critical part of our listening station, it's definitely cheap. Go buy yourself a DX-One Pro at double the price and I predict utter disappointment if you compare it with the K9AY (but I admit it takes up a lot less room).

Enough said?

Hardly! I and many other K9AY users will undoubtedly gain a lot of experience during the coming autumn and winter. Hopefully, by the coming spring, we will have found out a lot more about this fabulous tool. Well done, Gary Breed and Andy Ikin!

Resources:
John Bryant
Guy Atkins
Mark Connelly
K9AY Internet mailing list
Hard-Core DX Internet mailing list
Wellbrook Communications/Andy Ikin
Karen Milliken
DK9SQ/Walter Spieth
Nick Hall-Patch
W1WCR/Victor Misek (litterature)
ON4UN/John Devoldere (litterature)

http://www.wellbrook.uk.com/K9AY.html

Bjarne Mjelde, aged 42, lives in the extreme North and East of Norway and Europe, at N71 and E29. Bjarne has been DX-ing since 1972 and his favourite DX targets are MW stations from Asia, Pacific and North America. His radio shack comprises of a Kneisner & Döring KWZ-30 DSP receiver, an AOR AR7030+, and various preamps, splitters, phasers and other equipment. His home QTH in Berlevag gives room for 100-200 meter beverages. His resort in Kongsfjord, 34 km to the SE, has facilities for beverages 400 – 700 meters long. Bjarne lives with Reidhild, together they have an 11 year old son.