IRCA TECHNICAL COLUMN
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Loop Shoot-Out at East Harwich

(with special emphasis on Kiwa versus Quantum)

(Mark Connelly, WA1ION - 29 Aug 2001)

The most popular antennas among medium wave DXers are loops of a relatively compact size. These are often ferrite-rod based in the case of the Quantum models from RadioPlus (Gerry Thomas) as well as the Worcester Space Magnet and loops made by Palomar, Radio West, McKay-Dymek, and others. Compact air-core loops ("frame aerials" in older parlance) can be considered those under 50 cm / 20” diameter (round) or per side (square). The Kiwa Loop, considered by many as the best commercially-available medium wave loop, is a compact air-core design with a coil diameter of about 33 cm / 13".

Note that, in all the above cases, the loop head is relatively small and, therefore, a good deal of amplifier gain is required. This differentiates these loops from much larger ones that can operate passively through a coupling coil or ones that need only a slight boost from a lower gain amplifier, such as one of Dallas Lankford's, having superlative noise-figure and intermodulation-rejection performance.

Since many of us can't manage a hulking behemoth of a loop in our shacks, models such as the Quantum and the Kiwa have enjoyed a great deal of popularity.

High amplification, a "necessary evil" with physically-small antennas, has two principal limitations.

The first limitation, and with high-Q tuned circuits the more important, is noise floor. One cannot judge a high-impedance FET loop amplifier noise floor in a non-peaked condition. The LC-tank formed by the loop head coil and the tuning capacitor must be tuned to resonance (peaked) on an unoccupied frequency during non-skip midday conditions at a very electrically-quiet location. The ideal noise floor test site would be in an RF-shielded "screen room" of the type used by professional testing laboratories. Once the S-meter reading of amplifier noise at a given frequency is known, the weakest usable signal level can be estimated as being about 6 dB (or one S-unit) above this level. Anything weaker (at least AM signals) will not have recoverable audio and will only be detectable as a CW note or "het" against the receiver's BFO.

The second limitation of amplifiers is inadequate strong signal handling ability. Excessive input to the amplifier will cause harmonics to be generated. If two or more strong signal frequencies are present, mixing products can result, possibly covering up weaker "real" signals on the intermodulation distortion (IMD) frequencies. Except at the worst urban sites, this isn't too much of a problem with high-Q tuned loops properly peaked at the desired frequency.

The evaluations in this article concentrate mostly on weak-signal sensitivity and on overall gain. Urban DXers should probably stick to passive loops, possibly followed by a second stage of tuned preselection (and/or a wavetrapping notch filter to weaken the strongest local signal).

My home location in Billerica, MA often has too much electrical noise to permit serious low noise testing. I am fortunate to have the occasional use of a relative's house in East Harwich, MA on Cape Cod. RF noise is usually very low at this site since electrical power is delivered via underground conduits instead of overhead wires. This low noise environment and fairly close proximity (2 - 3 km) to the ocean mean that many long-distance medium wave and longwave signals can be heard, even during the daytime.

The 2250 km / 1400 mile distant groundwave of Radio Vision Cristiana (Turks and Caicos) on 530 kHz makes a good sensitivity test target. The car radio just gets a carrier at its noise threshold, but on my Drake R8A with a 30 m sloper from the top of a pine tree to the house, I get an S7 signal with readable audio (internal R8A preamp on; sloper to high-impedance receiver input).

The quiescent daytime noise floor on an open frequency when using the sloper is about S1 to S2. This is a combination of R8A built-in preamp noise and residual external "band noise" captured by the sloper. This is approximately equal to a -130 dBm signal level.

Active loops will have considerably higher open-channel peaked noise levels. The true measurement of interest is how much capture the loop's head has on very weak signals to push these signals over the amplifier's hiss. In the realm of signal audibility, a loop with a noise floor at S3 and a given weak signal reaching S4 is the same as a loop with a noise floor of S8 and the signal at S9. The only advantage the higher gain loop would have would be when operating into insensitive receivers (where an S4 "good receiver" signal would be down in the mud).

The Kiwa and Quantum Loops are pretty much state-of-the-art in squeezing weak signals out of a relatively small head. Their amplifiers are well-designed but still the overall packages are not going to be able to retrieve super-weak signals that could be heard with a considerably larger loop or, for that matter, a properly-matched wire antenna of 30 m length or greater.

Test data that follow focus on these attributes:

(1) Weak Signal to Noise (Sensitivity) Evaluation *(particularly important with good receivers)*

(2) S-Meter Gain *(of primary interest with less sensitive receivers)*

The Quantum Loop was tested with three different head types. These are:

- **Normal** head: plastic enclosure length = 8.5" / 21.6 cm
- **QX Pro** head: plastic enclosure length = 15" / 38.1 cm
- **Large** head (a prototype that Gerry made about 10 years ago): plastic enclosure length = 17" / 43.2 cm

The QX Pro Head covers longwave and medium wave (as selected by a switch). The longwave setting was used for medium wave tests below 650 kHz. Using the LW rather than the MW setting increases sensitivity about 3 dB on the low end of the broadcast band. I did minimal longwave testing; basically I just verified that the QX Pro does operate reasonably well down to 150 kHz and possibly lower. Numerous US and Canadian aerobeacons could be logged at any time. In the evening European and North African LW broadcasters were easily heard.

An old Quantum Loop base was compared to the newer QX base. The older base had slightly higher noise floor and slightly higher gain: the net difference in usable sensitivity was negligible. Quantum Loop measurements that follow are for the present QX / QX Pro base.

Regeneration on both the Kiwa and Quantum Loops raised both signal and noise floor about 20 dB (before oscillation) versus the non-regen. condition. Regeneration did not improve or reduce actual signal-to-noise ratio to any noticeable extent. The chief value of regeneration is to improve upon the receiver's IF filtering by giving, in essence, continuously-variable bandwidth. Cheaper receivers benefit more from this than do the better tabletop communications receivers.

Tests were performed during no-skip midday conditions, mostly in August 2001, at East Harwich, MA (GC = 70.021 W / 41.713 N) using a Drake R8A receiver set to 2.3 kHz bandwidth, AM mode, Preamp On.

Section 1: Weak Signal to Noise (Sensitivity) Evaluation

Table 1: Noise Floor

Antenna	Meter reading	Comment
Kiwa	S-5.5	
QX / QX Pro	S-8	with any head used
sloper	S-2	30 m, to R8A high-Z in

Table 2: Signal dB above Noise Floor: five weaker stations selected

Antenna	R.V.C - 530 over TIS's	WLUX/WDMV - 540 over CBT	CHTN - 720	CBA - 1070	Logan Airport TIS - 1650 over WHKT
Kiwa	+4	+15	+15	+15	+10
QX Normal head	$	+11	+14	+6	0
QX Pro head	+3	+14	+17	+9	+6
QX Large head	+5	+16	+20	+12	+10
sloper	+30	+36	+40	+33	+36

$ = below noise

Section 2: Gain Evaluation

Table 3: Strength of some Moderate to Good Signals on the Kiwa Loop

_	WEZE - 590	WBZ - 1030	WBAE - 1490 (over WHAV)
Kiwa	S9 + 30	S9 + 28	S-8

Table 4: Differences (dB) in Gain from Kiwa			
Antenna	WEZE - 590	WBZ - 1030	WBAE - 1490 (over WHAV)
QX Normal head	+9	+11	+9
QX Pro head	+14	+13	+12
QX Large head	+16	+15	+14
sloper	0	+4	+6
MFJ-1024 Whip	+4	+9	*
1.8 m per side square broadband loop with ALA-1530 amplifier	0	-8	*
* = *data not recorded*			

Conclusions and Additional Comments

In terms of weak medium wave station signal to noise (sensitivity), the ranking of the loops tested (best to worst) is as follows:

1. Quantum QX with Large (17”) head
2. Kiwa Loop
3. Quantum QX with QX Pro (15”) head
4. Quantum QX with Normal (8.5”) head

The differences between #1 and #2 or between #2 and #3 of the above list were very slight and would not make any difference in 99% of listening situations. The Quantum QX with the Normal head is a bit lower in signal-to-noise sensitivity (4 to 8 dB) than the front-runners, but it is still very capable for its size.

The Kiwa Loop has less “raw output” than the Quantum models, but unless you’re using a mediocre receiver, it’s signal to loop-amp noise that matters. In that department, as noted above, it’s a very close horse race. The Kiwa is varactor-tuned; the Quantums are tuned with a conventional variable capacitor. That the Kiwa has very good weak-signal pick-up indicates that speculations about varactors introducing objectionable noise seem unfounded.

The Kiwa has some advantages in terms of the head unit being separate from the control base (you’d put the head in a window or on a balcony if in a hotel, for instance), more precise rotation and tilting for nulls, and a fine-tuning control that’s particularly worthwhile when using regeneration.

An important advantage of the Quantum QX Pro is that it can be used on longwave as well as on medium wave. Also, the QX Pro head has an input for an external wire antenna. This can be useful in transforming the loop into a regeneration-capable tunable preselector for longwires. This is often done when the loop itself cannot be used because it’s located in a vehicle, mobile home, or steel-framed commercial building.

As the “East Harwich Loop Shoot-Out” showed, the Kiwa and Quantum loops are worthy “power tools” for the avid DXer. Prospective purchasers will do well to consider how the features, size, price, and performance specifications all interact to determine the wisest choice.

Kiwa Loop information
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(This article is also posted on the web, at
http://www.qsl.net/wa1ion/loop/harwich_loop_shootout.pdf)

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Tech filler bits

R.L. Measures submitted the following Beverage antenna tip to the Topband Reflector (http://lists.contesting.com/mailman/listinfo/topband):
“I used to run a 3-wavelength 8-ft. high beverage for 80m longpath into N. Europe. I found that there was a change in ground conductivity depending on rainfall. To be able to adjust the terminating resistance
remotely, I put a series string of fwd biased silicon diodes in series with a fixed resistor and adjusted the DC current through the beverage wire until I got the deepest null on signals off the back. When the diodes
were reverse biased, the beverage was bi-directional. Note: the forward biased resistance of a silicon junction is approximately 30 / current in mA -- i.e. 2mA makes for 30/2 = 15 ohms per diode.”

For those not on the IRCA e-group (info fromirca-owner@yahoogroups.com), the following from Chris Cuff (amstereoguy@hotmail.com) may be of interest:
“If anyone is interested, I have AM Stereo decoder modules available, fully assembled. They are the size of matchbook covers, and will work in any superhet with an IF freq of 450 to 456Khz. VDC in can be 6 to 24 VDC, as these have on board regulation. To see one, go to www.amstereoradio.com and click on "Chris Cuff's Handmade radios and Decoders". Cost is $25 each. Email me with any questions”