Beverages and Other
Low-Band Receive Antennas

H. Ward Silver, NØAX
Beverages and Other Low-Band Receive Antennas

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Any wire will work as an antenna, particularly if you don’t want it to...
Overview

- Goals of Receive Antennas
- Beverage Basics
- K9AY Loop
- Flags and Pennants
- Vertical Arrays
- Small rotatable loops
- Coupling and Pickup
Receive Antenna Goals

- Gain is **NOT** the goal
  - Sensitivity at HF is more than adequate
  - The signals are there but covered in noise
- Directivity **IS** the goal
  - Avoid receiving the noise in the first place
  - Not more signal…less noise!
  - Signal-to-Noise Ratio (SNR)
  - Receive Directivity Factor (RDF)
Receive Antenna Goals

- Gain is *NOT* the goal
- MF and HF receiving is limited by noise
  - Atmospheric versus man-made noise
  - Reject off-direction noise
  - Null out local sources
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Beverage Background

- Invented in 1921 by Harold Beverage W2BML for LF (<300 kHz)
- Long, low wires... very long
- Works best close to ground with medium to poor conductivity
- Advantage lies in rejecting noise from unwanted directions
Beverage Basics #1

• Wavefront Tilt
• Field Components
• Vertical and Horizontal Polarization
Incoming wavefront electric field

Vertical component \textit{(no effect)}

Horizontal component \textit{(causes current)}

Tilt angle

Tilt mostly caused by angle-of-arrival at MF
Beverage Basics #2

- Termination & Characteristic Impedance
- Travelling-wave / Non-resonant
- Best from 3/4 - 5 wavelengths
Wavefronts arriving induced voltages

To receiver

ground

Wavefronts arriving

Signal Absorbed

To receiver

ground
How Are Signals Rejected?
Horizontally-polarized along axis, no effect because E-field is perpendicular to the antenna - no current!
Vertically-polarized broadside, no effect because E-field is perpendicular to the antenna - no current!

Horizontally-polarized along axis, no effect because E-field is perpendicular to the antenna - no current!
Vertically-polarized broadside, no effect because E-field is perpendicular to the antenna - no current!

Horizontally-polarized broadside, no effect because E-field causes same current everywhere, canceling at ends!

Horizontally-polarized along axis, no effect because E-field is perpendicular to the antenna - no current!
The Classic One-Wire Beverage

Receives best from this direction

50 Ω

1:9

4 to 15'

ground

300-600 Ω
The Two-Wire Beverage

Left-to-right Signals

Right-to-left Signals

Balanced line acting as the antenna

Reflection Transformer

January 2015 Beverages and Receiving Antennas
Signal from the right

Signals are **in-phase** on each wire
Signals **sum** in the T2 center-tap, no primary output
T3 transfers the summed signals to feedline

**Left-to-right Signals**

- 50 Ω
- T2

**Right-to-left Signals**

- 50 Ω
- T3

Reflection Transformer

1:9

1:1

January 2015 Beverages and Receiving Antennas
Signal from the left

Signals are in-phase arriving on each wire. Transformer converts common-mode to differential. Signals now travel to left inside xmsn line. T2 transfers signal to feedline, T3 nulled.
Do They Work?

- You betcha!
  - 160 meters: from 1-2 S-unit
  - 80 meters: from 2-3 S-units (or more!)
  - 40 meters: not much improvement
- You can hear at least one more ‘layer’
- Reduces operator fatigue greatly
Useful Beverages

• ½-wavelength can help
  – 160 meters – 250’, 80 meters – 125’
• “Big Guns” recommend 1 wavelength
• “Temporary” Beverages
• Beverage on ground
• Low-Band DXing, Top-Band reflector
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K9AY Loop

- Near-triangular loop
- Single-support, 25’ high
- Modest directivity
- Low-cost
- Good for home and portable operation
K9AY Loop

Total wire needed
85 ft (26 m)

25 ft
(7.5 m)

5 ft
(1.5 m)

15 ft (4.5 m)

15 ft (4.5 m)

Feedline

Ground Rod

XFMR

Termination
Elevation Pattern

Azimuthal Pattern (30°)

Gain is approx -26 dBi
F/B is 20 to 40 dB
Deep null at 40°
K9AY Loop

- Requires preamp (10-20 dB)
- Single ground rod ok for normal soil
- Disconnect from rcvr when transmitting
- Nearby metal or antennas affect pattern
- Suggest burying or decoupling feed line
- See K9AY QST articles and website – www.aytechnologies.com
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Flags and Pennants

- Small rectangle, triangle, or diamond
- Oriented vertically
- About 29 feet long, 14 feet high
- Mounted 6 feet or more above ground
- Relatively insensitive to ground
- Requires preamp (20 dB)
- Max signal in direction of feed point
From July 2000 QST article by K6SE
Gain is -30 to -36 dBi
F/B is about 20 - 40 dB
Deep null at 30° (dep on height)

From July 2000 QST article by K6SE
Rotatable Flag

w7iuv.com/flag.htm
March 2011 QST article by WB6RSE
Double Half-Delta Loop

22 m long

7.5 m high

1.5 m above ground

Used on TX3A expedition by AA7JV & HA7JY
Est to be 2.5 dB better than a single flag

tx3a.com/docs/TX3A_DOUBLE_HALF DELTA_LOOP.ZIP
Shared Apex Loop Array (SAL)
SAL Basics

- Four identical right triangle loops
  - Vertical sides supported by a non-conductive mast.
- Directivity from summing signals from one loop with delayed signals from an oppositely phased and positioned loop.
- Delay and loop phasing largely frequency independent
  - Creates directivity over a wide frequency range
- From www.widebandloop.com/Technology.html
Online Resources

- K3KY’s Flag and Pennant web page
  - www.angelfire.com/md/k3ky/page37.html
- WA1ION’s web site
  - www.qsl.net/wa1ion
- W7IUV’s web site
  - w7iuw.com
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- **Vertical Arrays**
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Vertical Arrays

- Basically miniature vertical arrays
- DX Engineering, Hi-Z Antennas
  - 2/4/8 antenna arrays
  - Active and passive elements
  - dxengineering.com, hizantennas.com
- NCC-1 Noise Cancelling Controller (DXE)
  - Combines two rx antennas
Typical 4-element Array pattern

8-element array physical layout

From Hi-Z Antenna product literature
## Array Size

<table>
<thead>
<tr>
<th>Band</th>
<th>Freq - MHz</th>
<th>Optimal Side Length in Ft</th>
<th>Min. Side Length in Ft</th>
<th>Max. Side Length in Ft</th>
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<td>160</td>
<td>1.83</td>
<td>135</td>
<td>54</td>
<td>270</td>
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<td>80</td>
<td>3.60</td>
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<td>40</td>
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<td>70</td>
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<tr>
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<td>1.83, 3.60</td>
<td>98</td>
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<td>1.83, 3.60, 7.10</td>
<td>70</td>
<td>28</td>
<td>137</td>
</tr>
</tbody>
</table>

From DX Engineering product literature

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Small Magnetic Loop

- Often referred to as “shielded” loops
  - Shield acts as a balanced antenna
  - Signal coupled to center conductor
- Loop responds primarily to H-field
- Loop is tuned to resonance
- Symmetry forms null in plane of loop
- Rotatable to aim null at noise source
Diameter of 4 to 6 feet

Hardline
RG-213/11
RG-58/59/62

Capacitor tunes loop to resonance (1000 pF trimmer)

From W8JI
www.w8ji.com/magnetic_receiving_loops.htm
W8JI Loop Guidelines

- The shield must be perfectly symmetrical moving away from the inner conductor exit point.
- The gap in the shield must be exactly opposite the grounded point.
- The ground must be at the inner wire exit point.
- The shield will not make an unshielded loop that is properly balanced any quieter.
- The shield only is a tool to help you balance the system. The shield helps only when the shield is properly implemented.
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Coupling and Pickup

- Coupling and Pickup are **BAD**!
- Bury or isolate feed lines
- Coupling destroys symmetry
- Shields pickup noise
  - 1:1 isolation transformers
  - Common-mode ferrite chokes
  - ARRL Handbook and Antenna Book, K9YC online tutorials
Summary

- Gain is not the objective
- Better SNR is the objective
- Use the pattern
- Preserve the pattern
- Small antennas are sensitive
- Keep noise and coupled signals out!
- A dB is a dB is a dB (thanks K7GCO)
!!Thank You!!