

SMALL TRANSMITTING LOOPS (STLs)



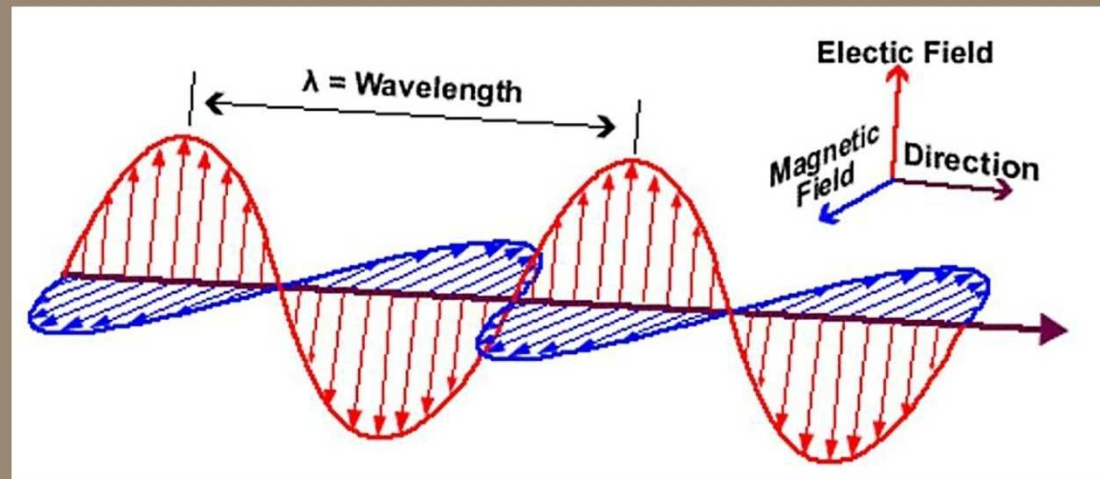


AGENDA

- What are STL's and why so popular.
- Pros and cons.
- Radiation patterns.
- Construction considerations.
- Commercial examples.
- Homebrew examples.
- Audio demo comparing STL to G5RV and groundplane.

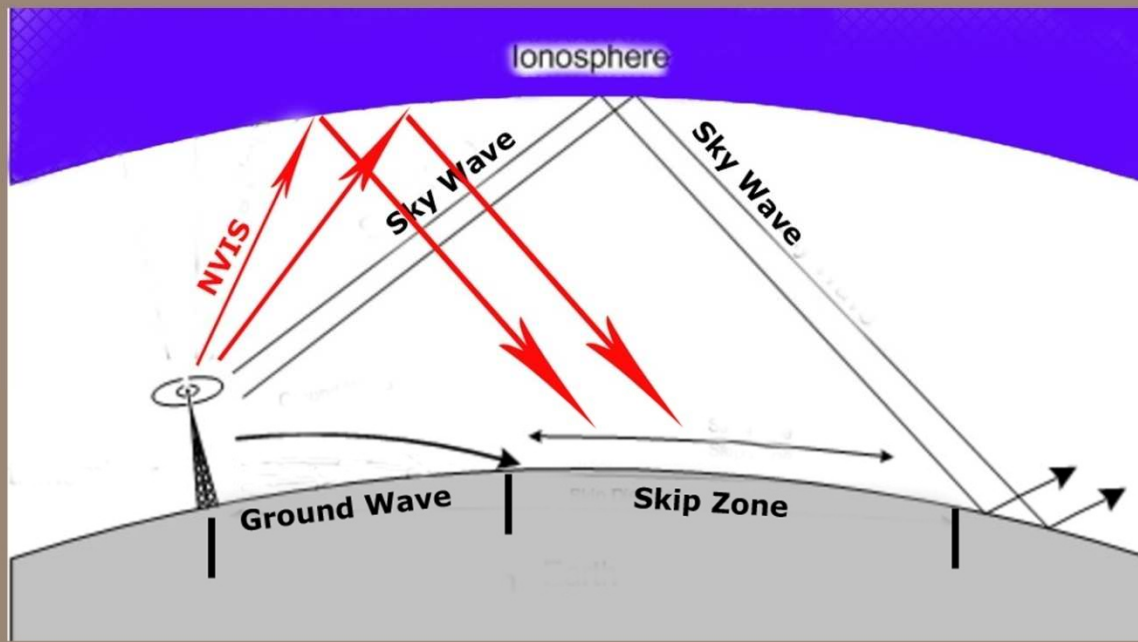
TERMINOLOGY

- Magnetic field - H field
- Electric field - E field



TERMINOLOGY

- **Near Vertical Incidence Skywave, (NVIS),** is a skywave radio-wave propagation path that provides usable signals in the range between groundwave and conventional skywave distances, usually 30–400 mile

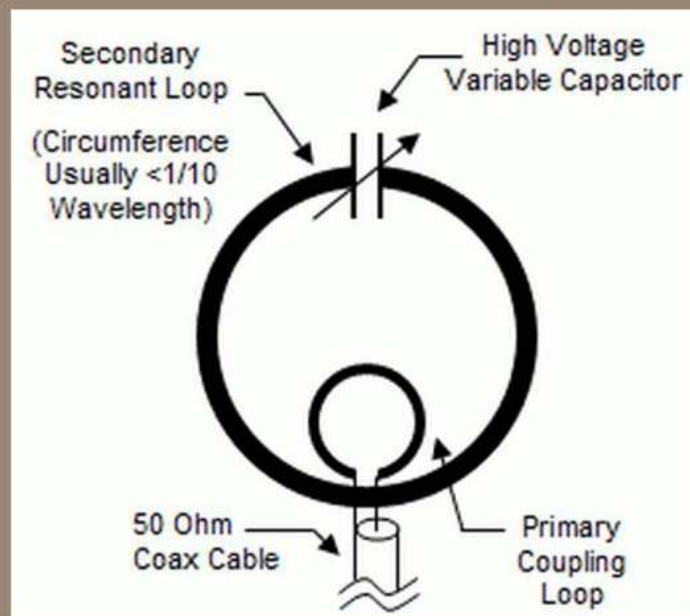


SMALL TRANSMITTING LOOPS (STL)

- **STLs are also known as Magnetic Loop antennas.**
- **Very popular in Europe for years as so many Europeans live in apartments or condos.**
- **Becoming popular now in US due to covenants.**

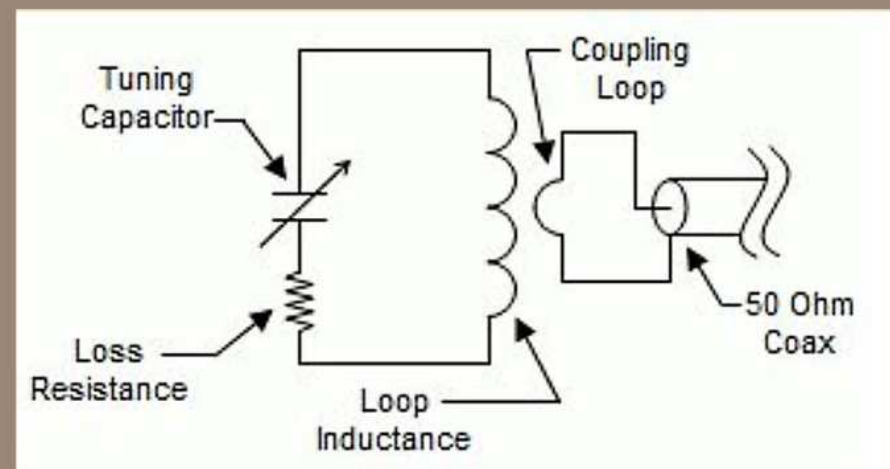
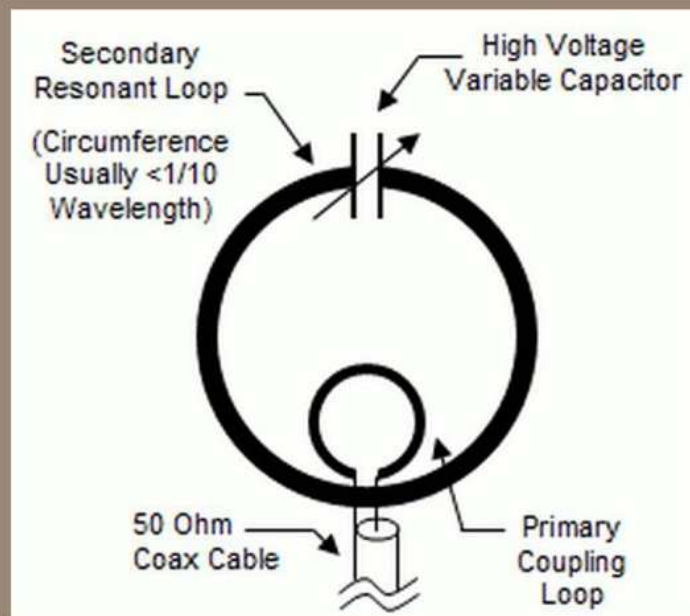
WHAT IS AN STL?

- A parallel tuned circuit consisting of:
 - A loop with a circumference $< 1/3$ wavelength at the highest frequency.
 - A capacitor to resonate the circuit.
 - An impedance matching network.
 - Circumference can be circle, rectangle, or octagon.



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WHY ARE STLs POPULAR?

- Small size with high efficiency.
- Very close to the efficiency of a dipole.
- Relatively stealthy.
- Multiband.
- Do not require radials.
- Can be operated very close to the ground when mounted vertically.
- Very low receive noise.

STLs - PROS

- 2:1 frequency range (10 meters to 30 meters).
- Filtering effect:
 - Narrow bandwidth puts a “filter” in front of the receiver.
- Noise rejection:
 - Linear antennas (dipoles, verticals, and beams) respond to E fields.
 - STLs respond only to H fields:
 - Don't respond to the local noise's predominate E field.
 - In noisy enviroment, STL's SNR is 10 to 20 dB better than dipole's SNR.

STLs - PROS

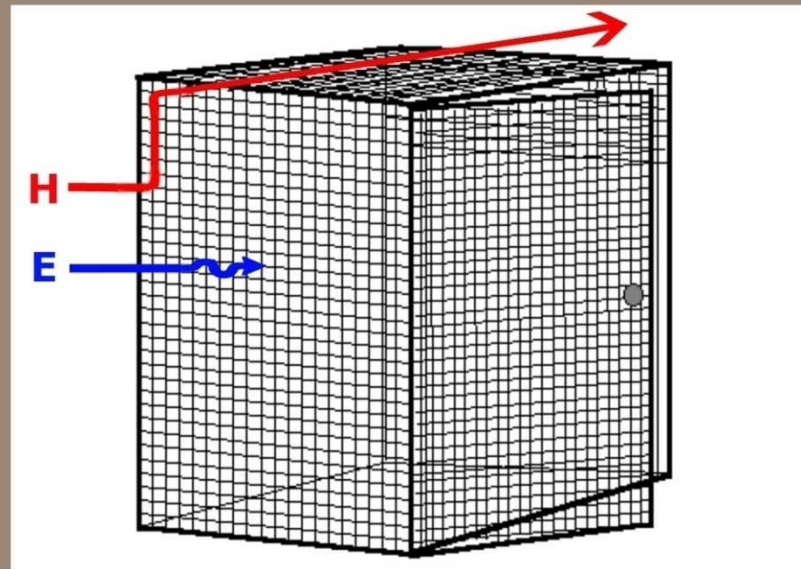
- No ground plane required.
- Unlike horizontal antennas, works well near the ground:
 - Little gained when raising the STL higher than 1 loop diameter.
- Due to the STL's near H field, ground conductivity isn't a critical factor.

STLs - PROS

- Nulls for reducing interference:
 - Has deep narrow nulls perpendicular to the loop's plane.
- High and low angle radiation:
 - Vertical radiates from horizon to vertical.
 - Good for low angle DX to high angle NVIS.

STLs - PROS

- Unlike E field antennas (dipoles), STLs work very well indoors.
- STL's near H field cannot be blocked (Maxwell's Equations) by house wiring, plumbing, etc.
- A Faraday cage shorts out the E field but routes the H field around it.



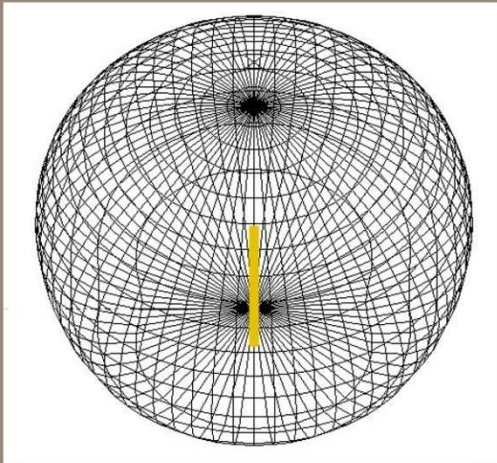
STLs - CONS

- **Narrow bandwidth:**
 - Remote tuning required.
- **Low radiation resistance:**
 - Very large RF currents in loop.
 - (Up to 20 amps @ 100w).
 - Requires welded conductor joints.
 - Butterfly capacitors or vacuum variable capacitors:
 - No pressed plates or wipers.
- **Very high capacitor voltages (Up to 7 KV @ 100w)**

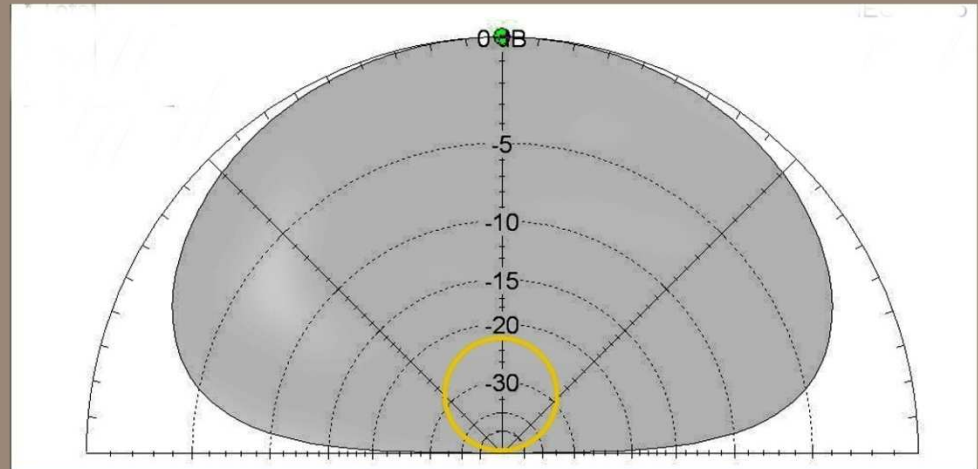
ADVANTAGE OVER DIPOLES & VERTICALS

- **Dipole:**
 - Must be high (20m - 33', 40m - 66') for low angle radiation.
 - Good for either high or low angle radiation.
- **Vertical:**
 - Low angle only.
 - Requires lots of radials.
- **STL:**
 - Has none of these issues.

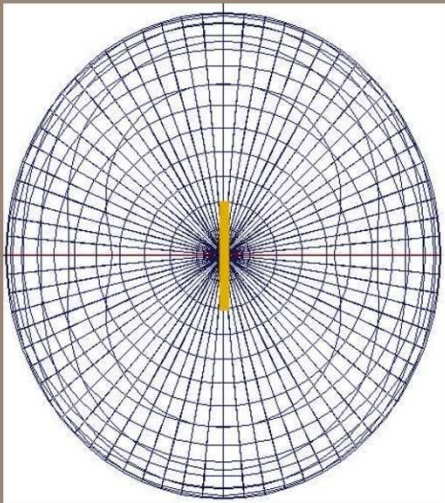
VERTICAL STL RADIATION PATTERN



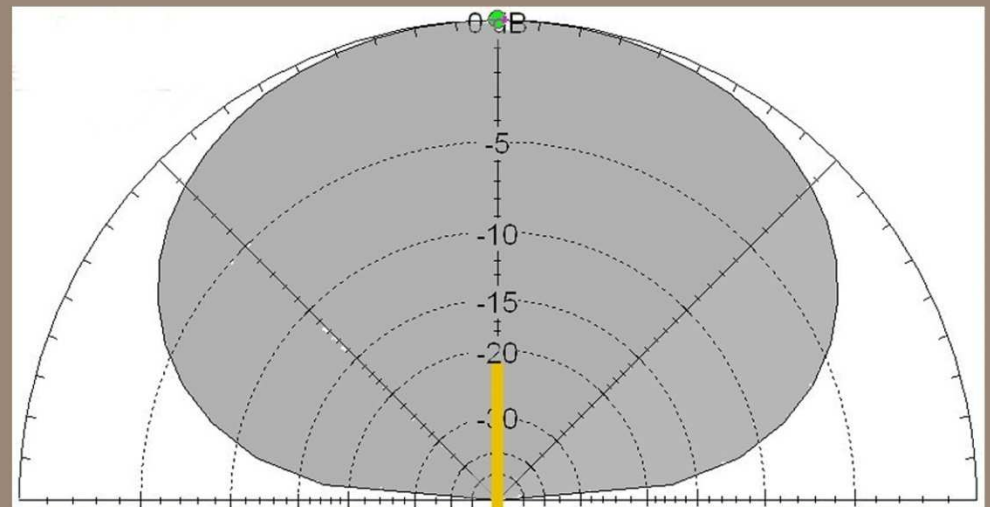
View from 45 degrees



Side view



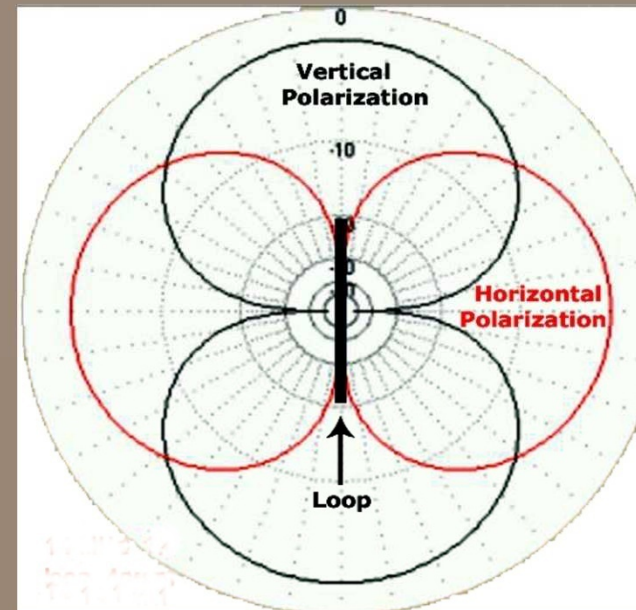
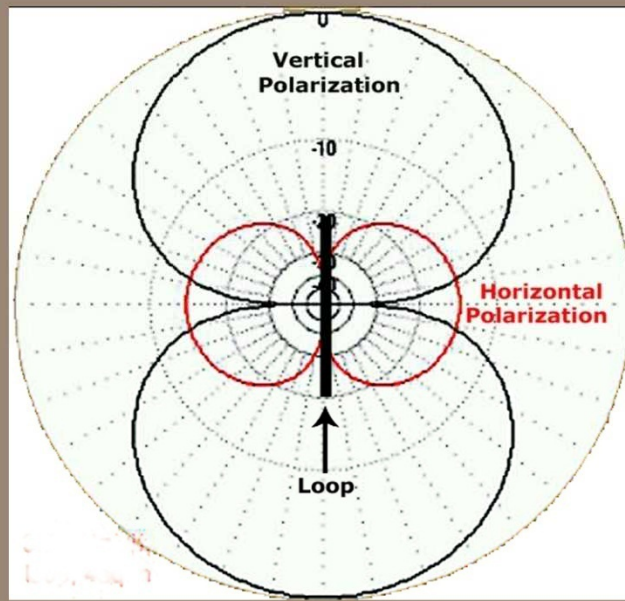
View from 90 degrees



End view

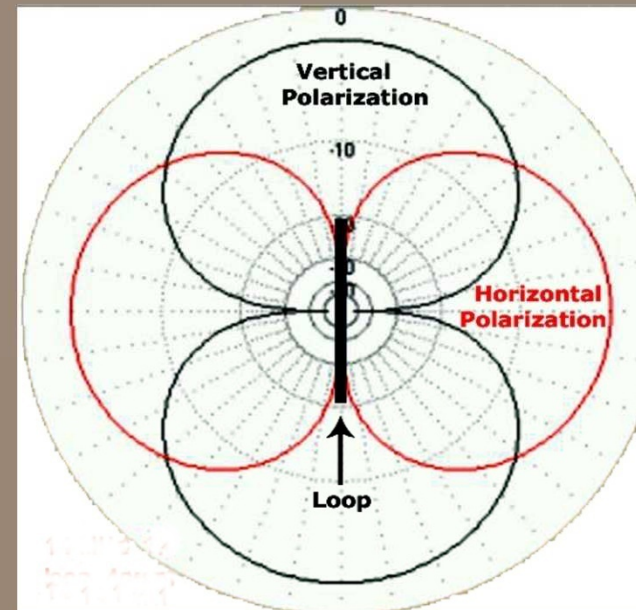
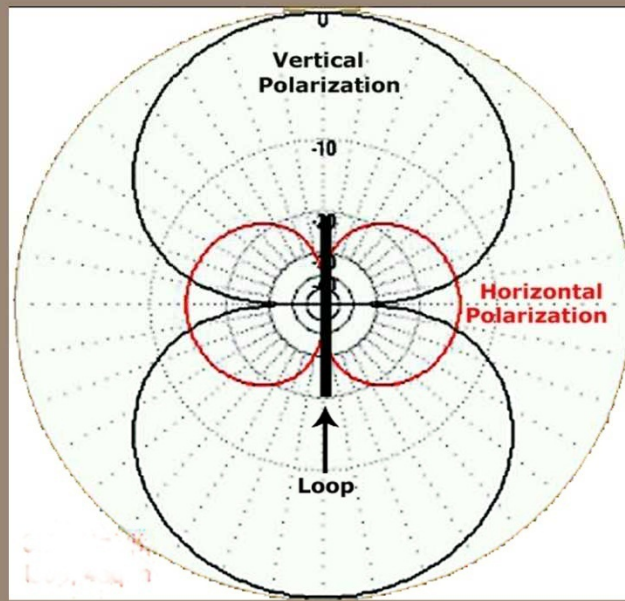
VERTICAL STL RADIATION PATTERN

- At low angles, the vertical polarized H field is maximum and the horizontal polarized H field is minimum.
- As the angle increases the vertical polarized H field decreases and the horizontal polarized H field increases.



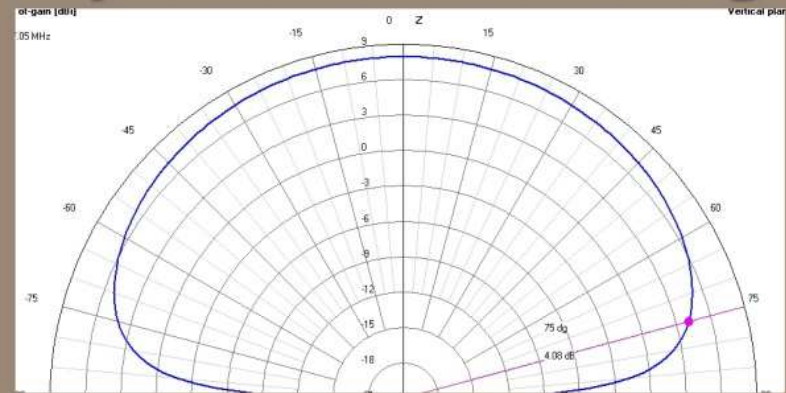
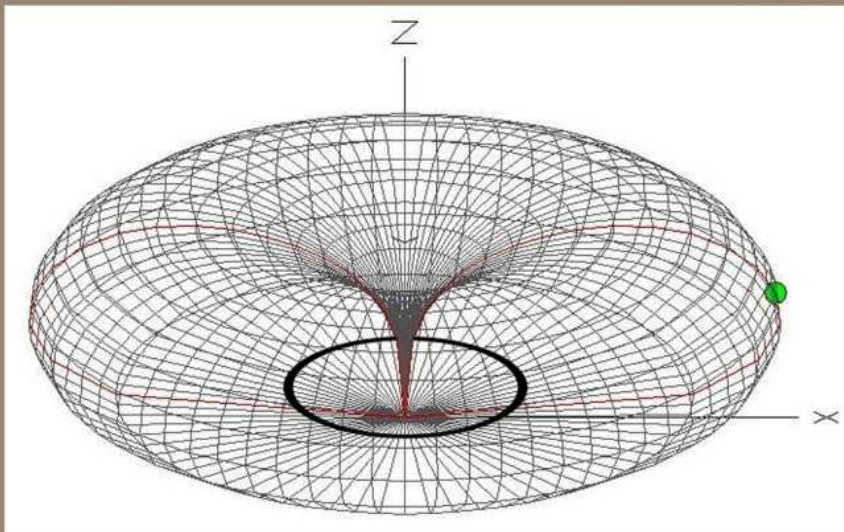
VERTICAL STL RADIATION PATTERN

- At low angles, figure 8 pattern in the plane of the loop with a deep null perpendicular to the plane of the loop. Good for nulling out interfering signals.
- At high angles, omni directional pattern with horizontal and vertical polarizations.
 - Less fading due to incoming polarization shifts.

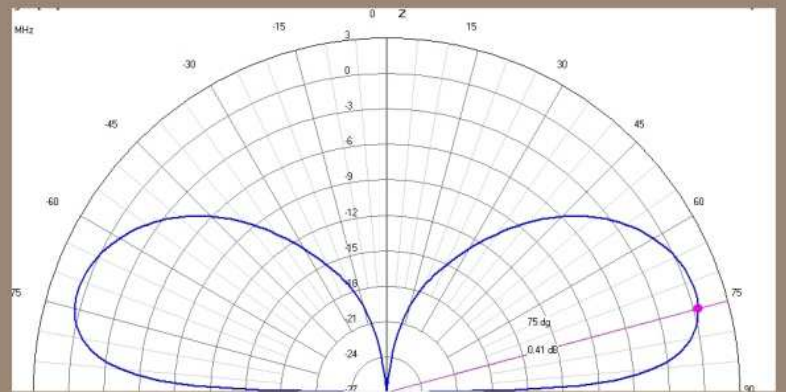


HORIZONTAL STL RADIATION PATTERN

- Donut shaped horizontal polarized pattern.
- Take off angle is same as dipole relative to height above ground.



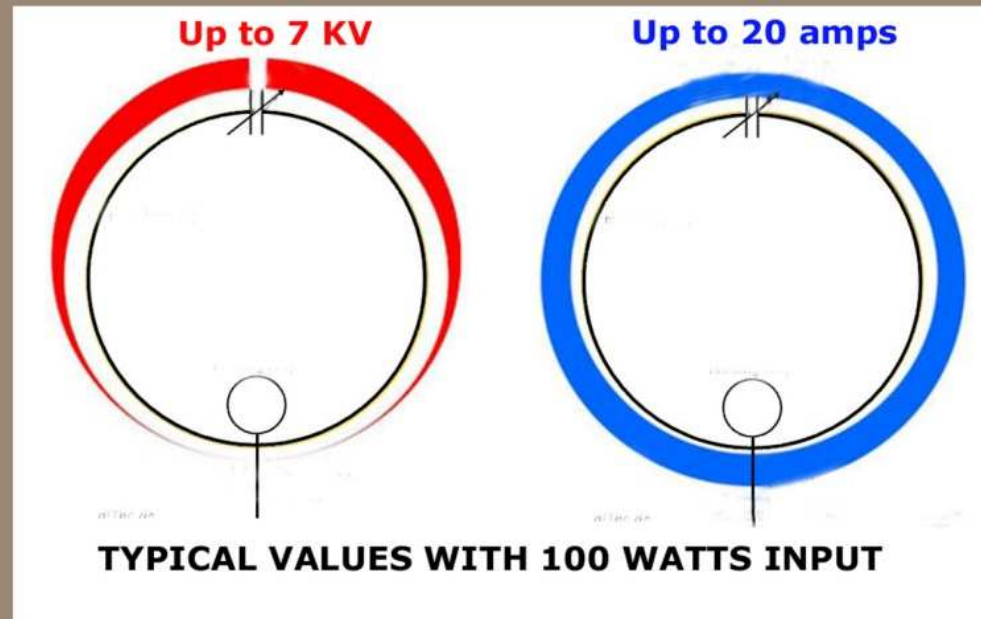
$1/4\lambda$



$1/2\lambda$

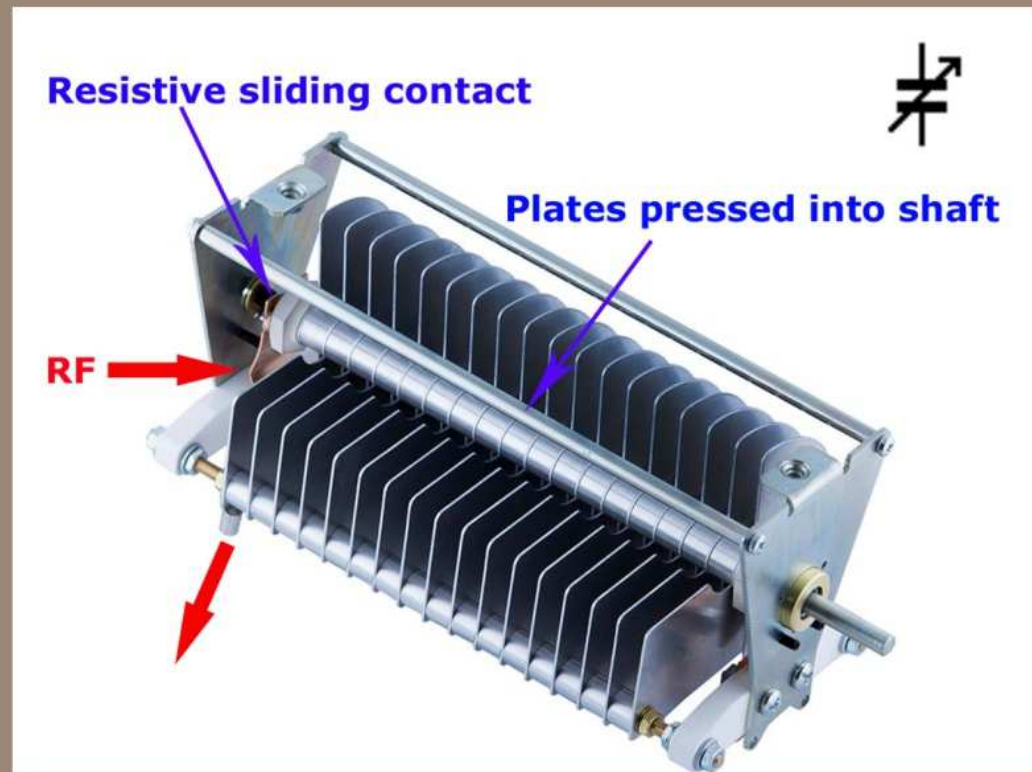
STL CONSTRUCTION CONSIDERATIONS

- Due to the extremely low loop radiation resistance (0.065 ohms), large voltages and currents result:
 - Extremely low resistance construction is imperative.
 - Special low resistance/high voltage capacitors are required



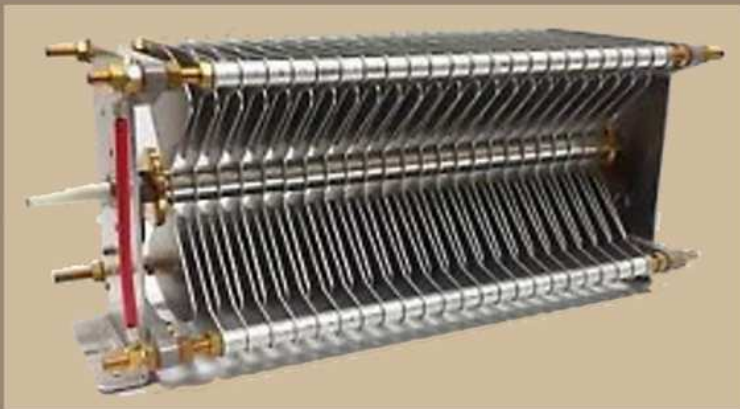
STL CONSTRUCTION CONSIDERATIONS

- Standard variable capacitors cannot be used:
 - Sliding contacts have resistance.
 - Plates pressed into tuning shaft have resistance.

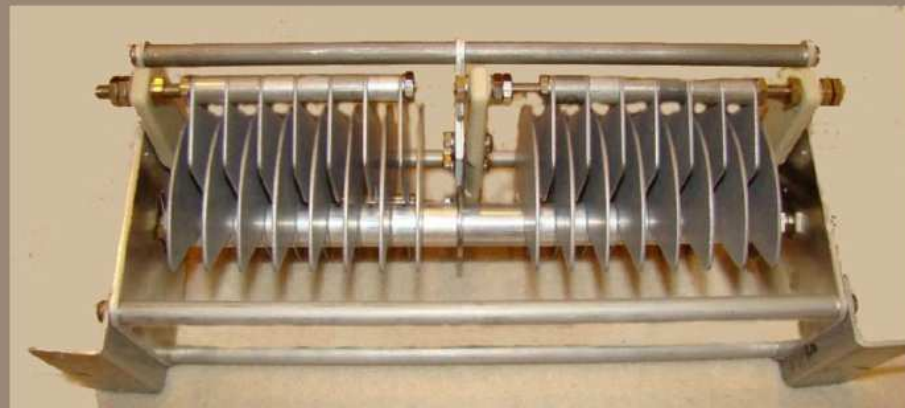


STL CONSTRUCTION CONSIDERATIONS

- Butterfly and Split Stator capacitors are preferred as there are no resistive slider contacts.
- The Split Stator capacitor must have plates welded to the tuning shaft.



Butterfly



Split Stator

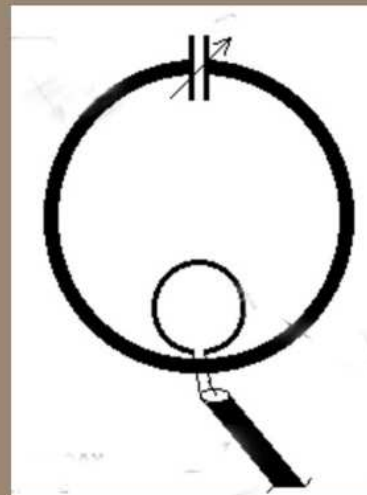
STL CONSTRUCTION CONSIDERATIONS

- Vacuum variable capacitors are preferable though expensive.
- Use a high vacuum as the dielectric instead of air allowing for a higher voltage rating in a smaller total volume.
- Has less internal signal resistance.

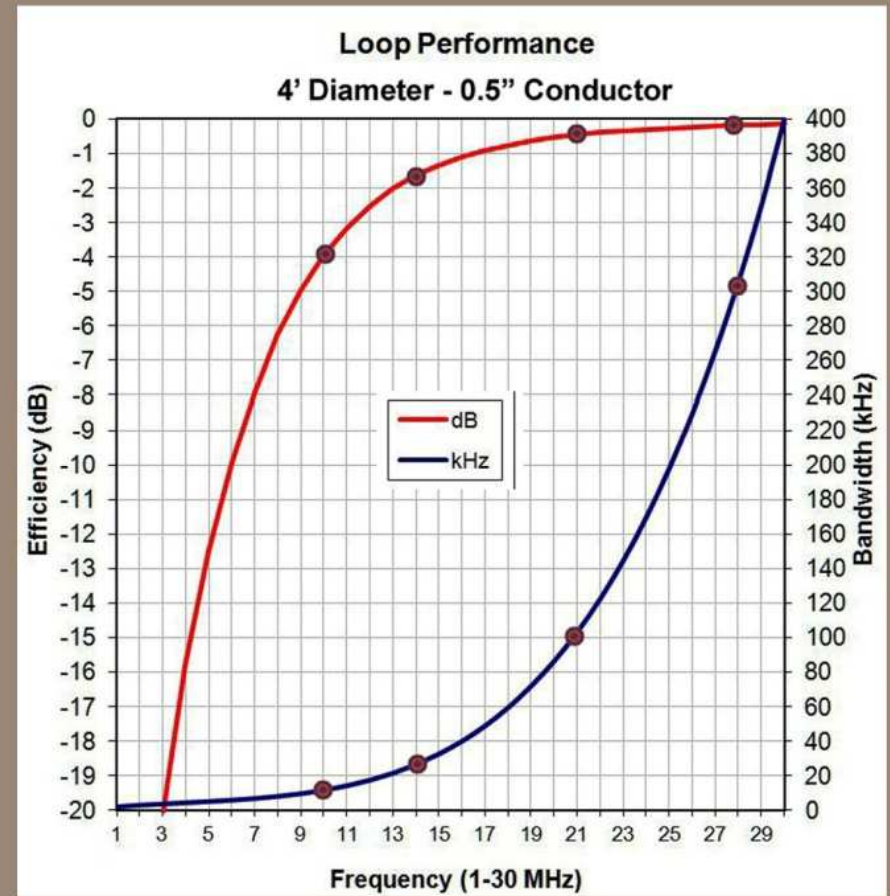
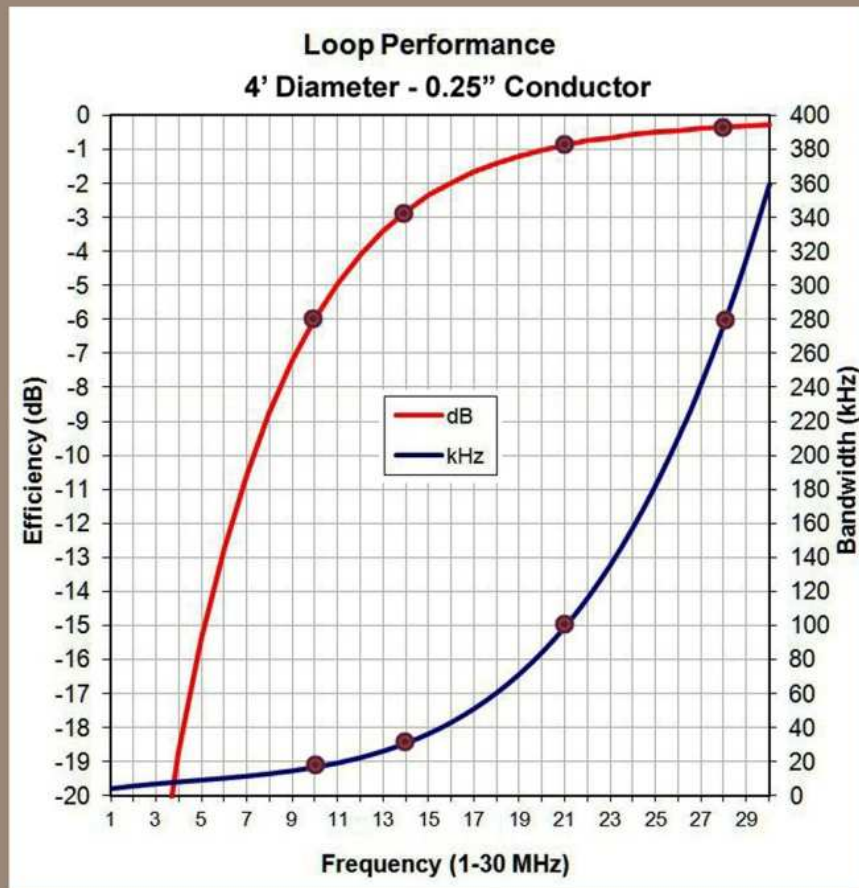


STL CONSTRUCTION CONSIDERATIONS

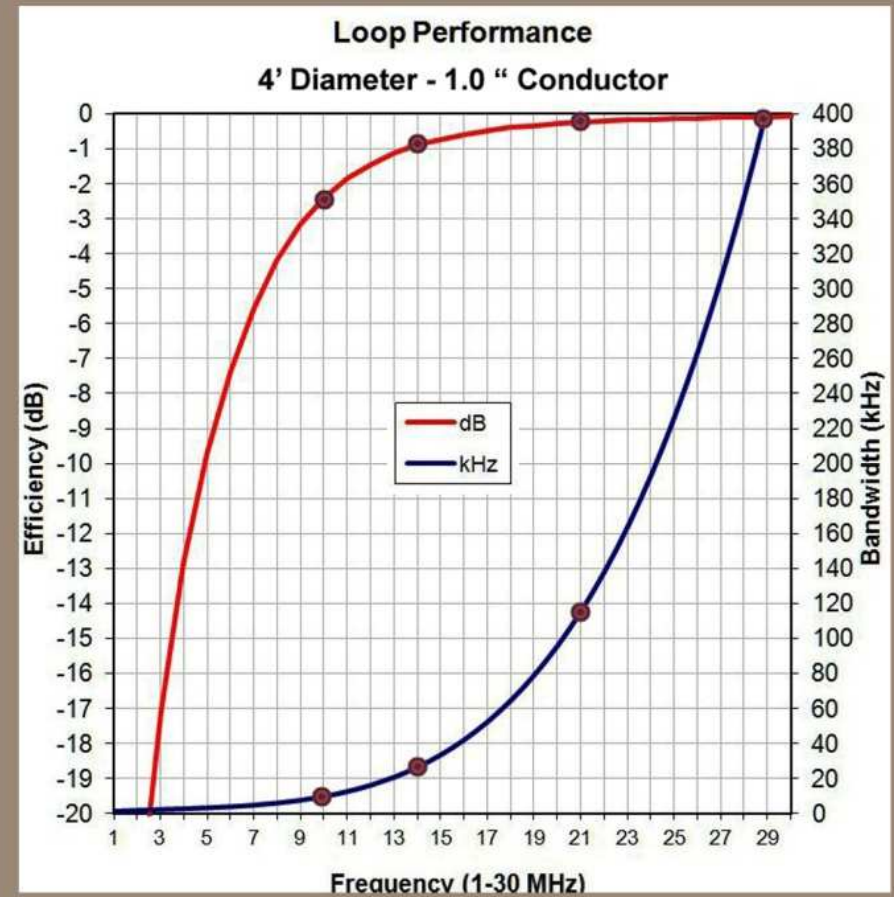
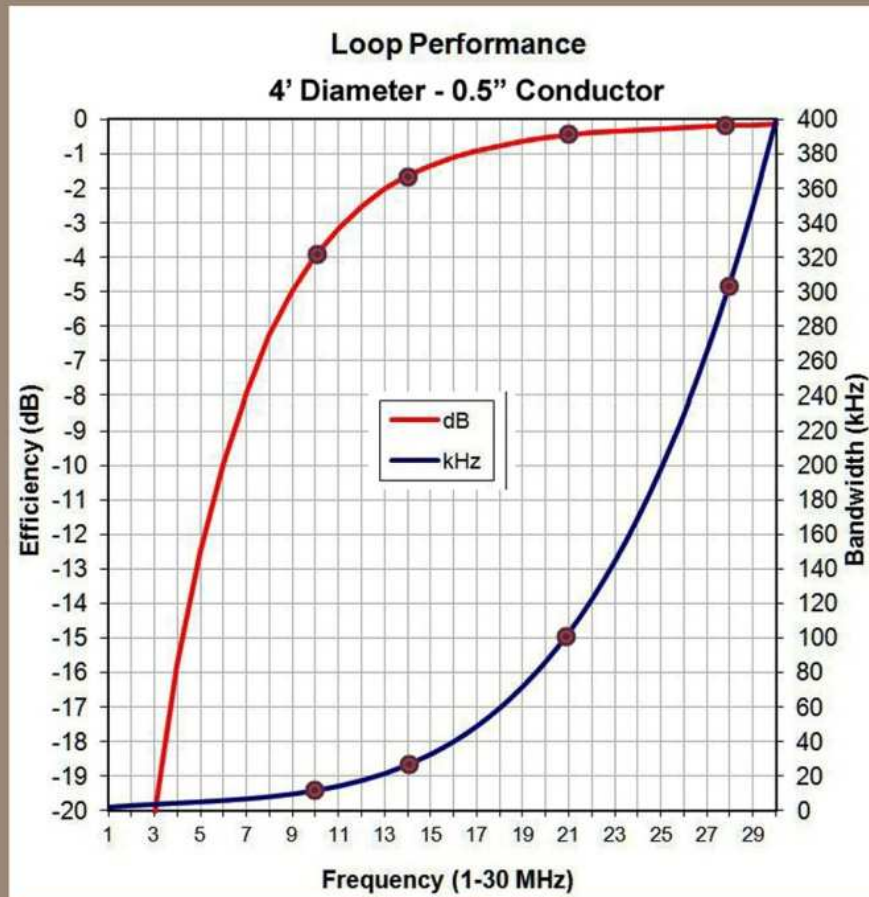
- The larger the conductor diameter, the less the loss and the more efficient the loop.
- Copper has lower loss than aluminum.
- All joints must be soldered.



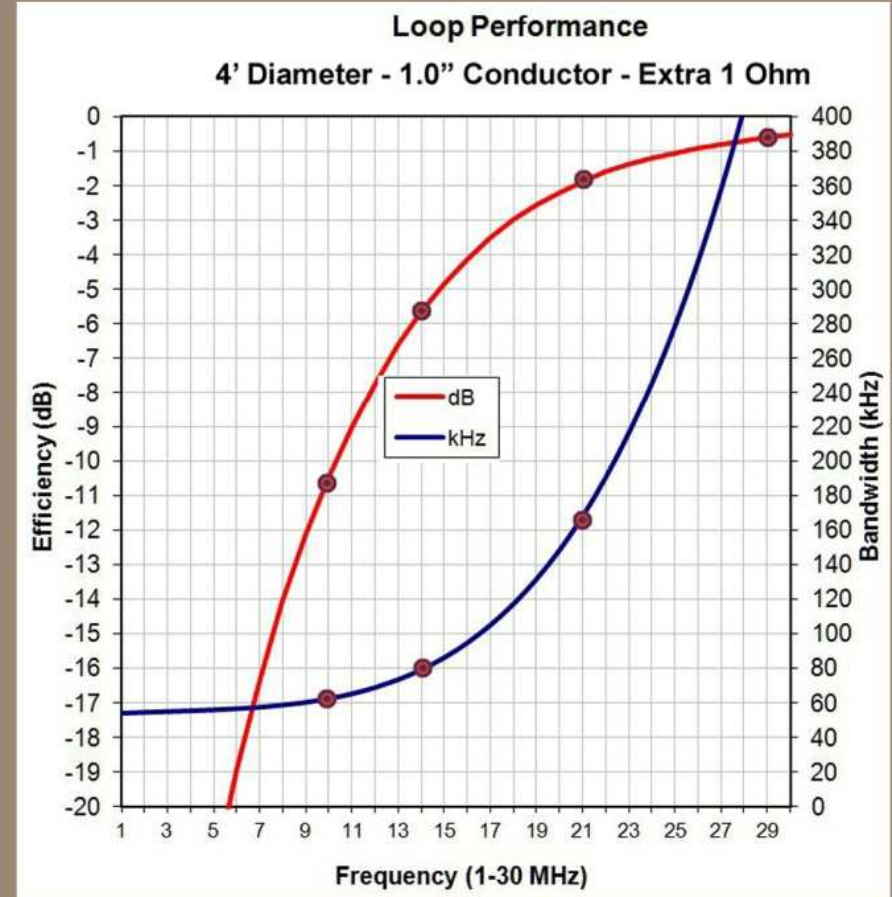
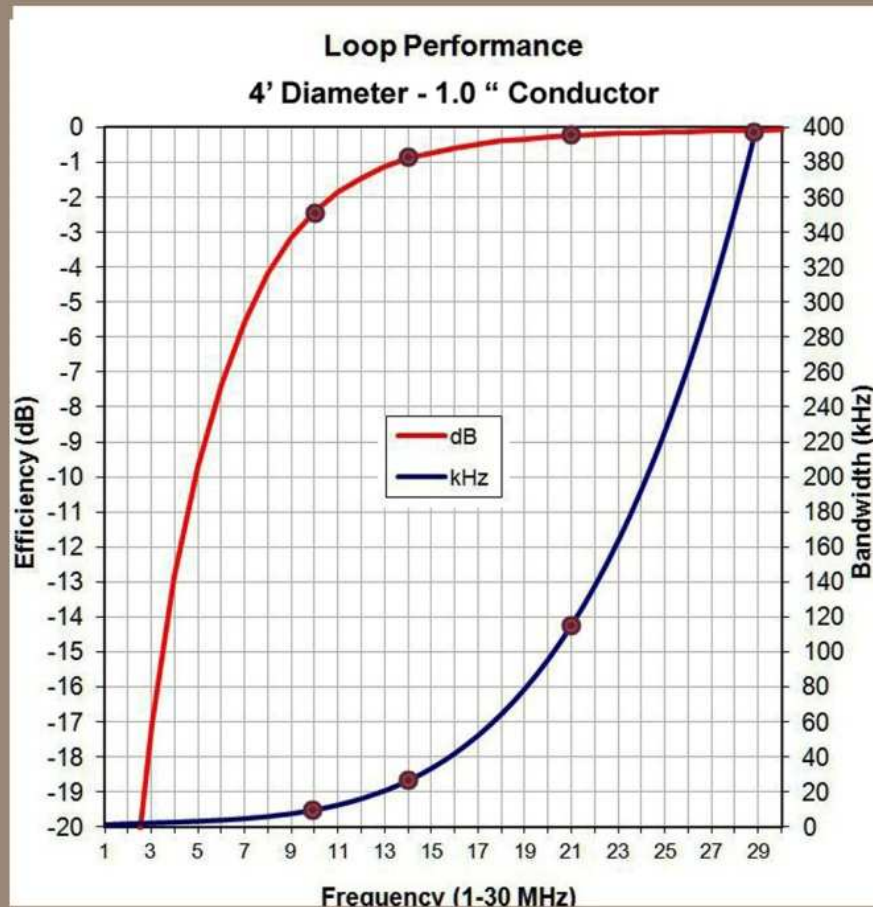
STL CONSTRUCTION CONSIDERATIONS



STL CONSTRUCTION CONSIDERATIONS

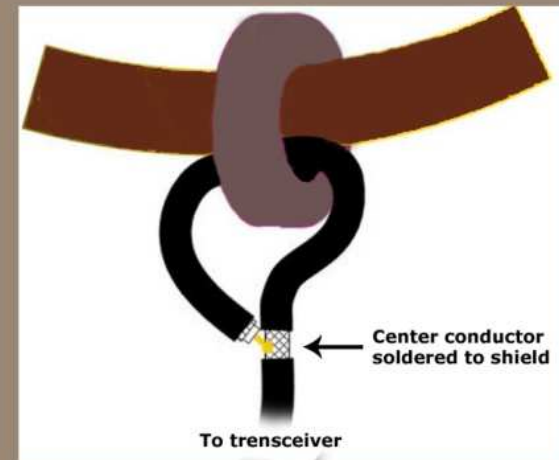
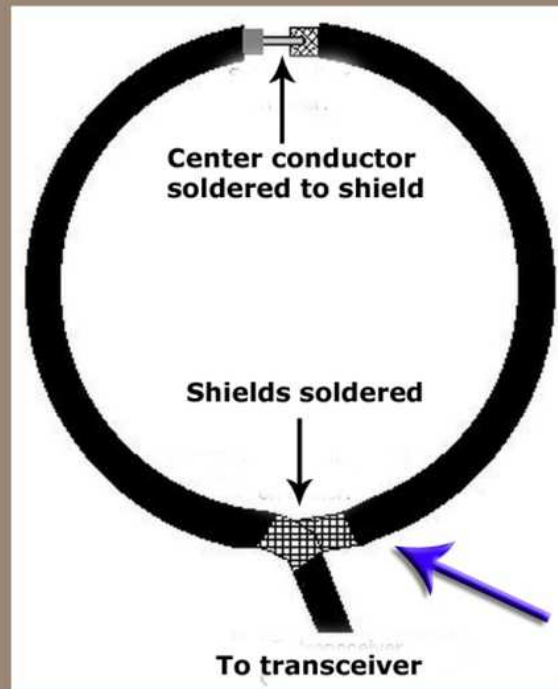


STL CONSTRUCTION CONSIDERATIONS



STL CONSTRUCTION CONSIDERATIONS

- Three common matching systems: Gamma, Faraday and toroid core.



1/5 Loop Diameter

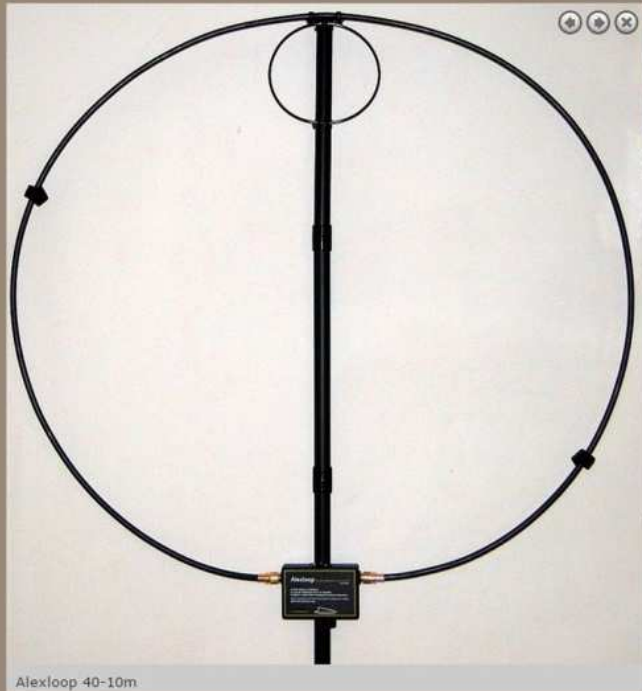
COMMERCIAL STLs

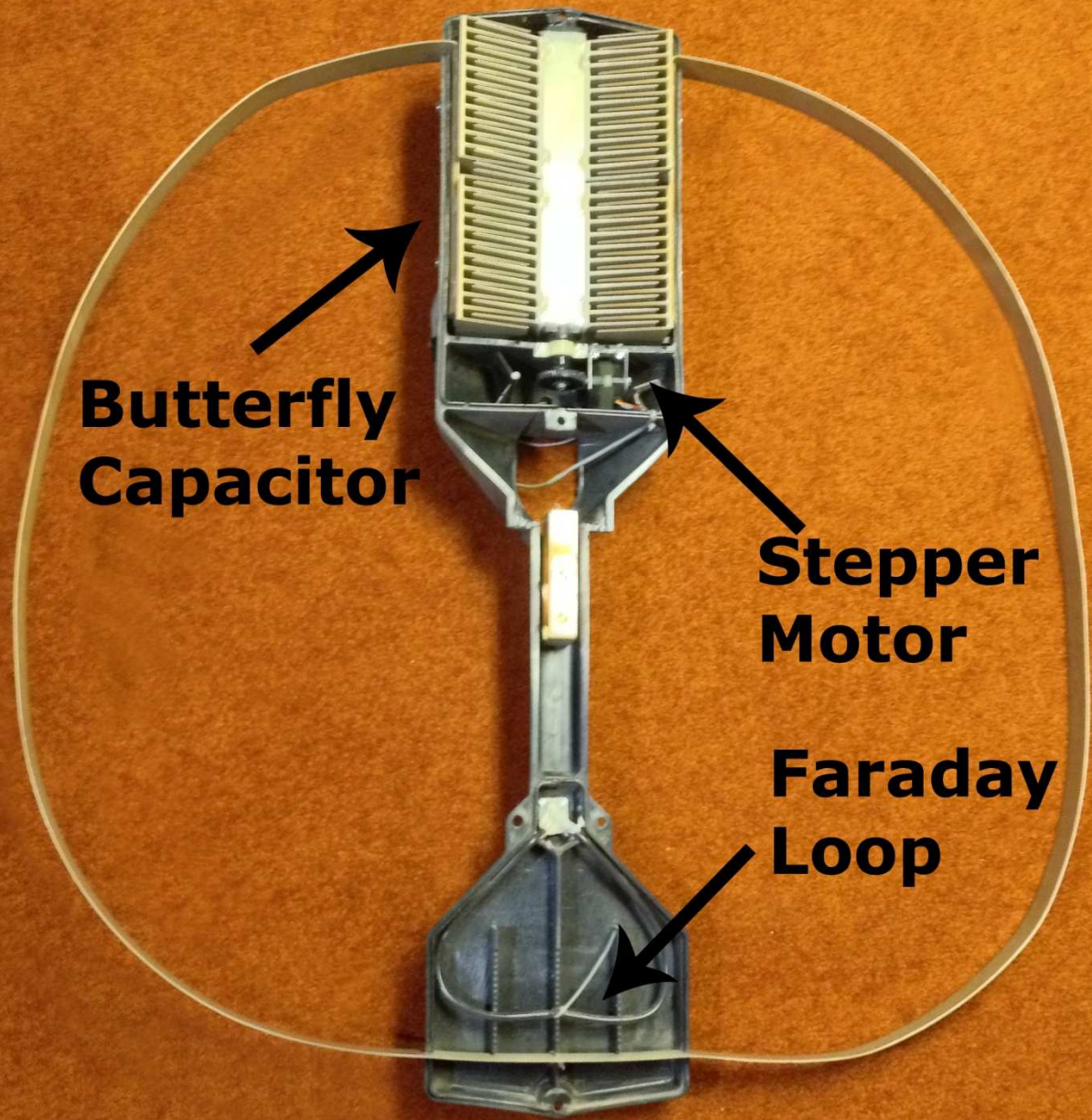


COMMERCIAL STLs



COMMERCIAL STLs





**Butterfly
Capacitor**

**Stepper
Motor**

**Faraday
Loop**

COMMERCIAL STLs



COMMERCIAL MOBILE STLs

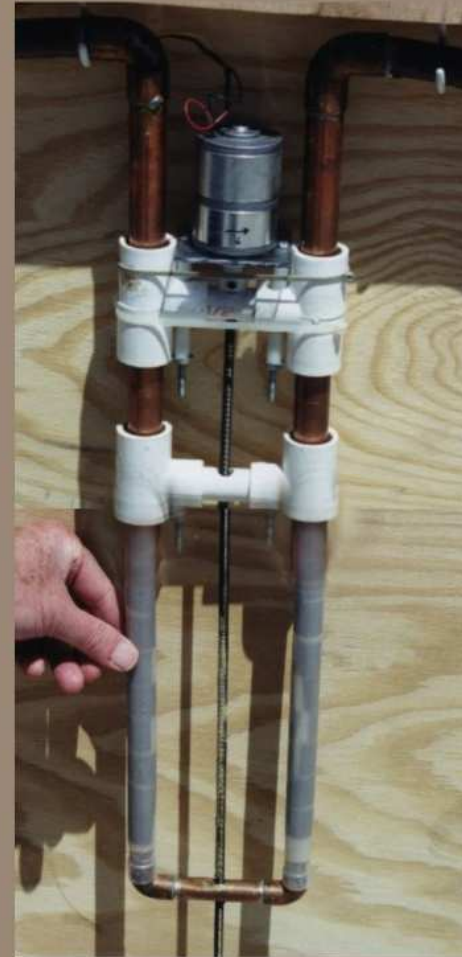


Barrett Communications, Australia
Frequency range: 3.9 to 12.2 MHz
Performance: 10 to 14 dB better than a whip.

MILITARY MOBILE STLs



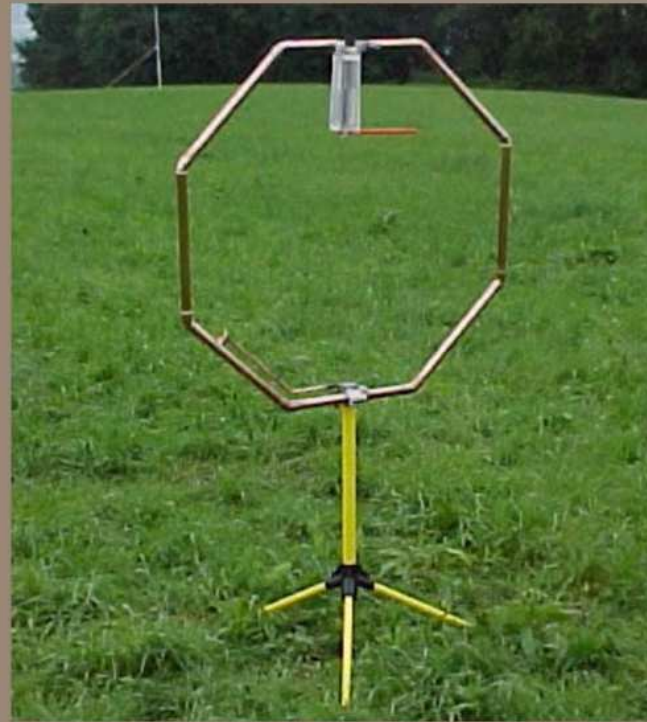
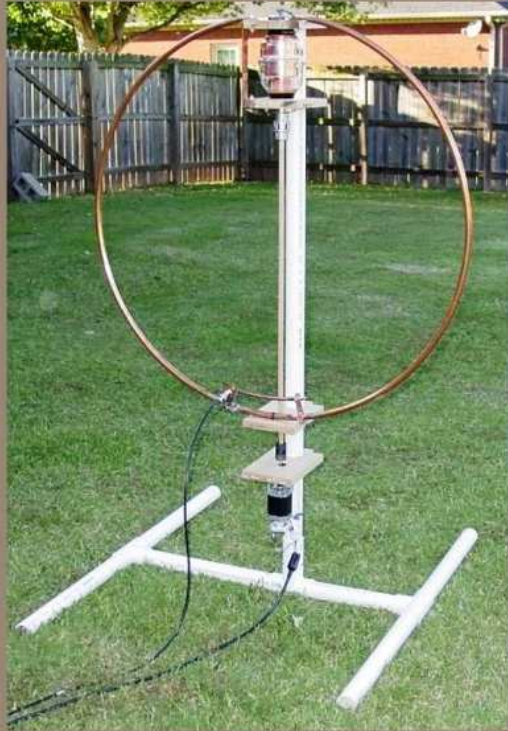
HOMEBREW STLs



HOME BREW STLs

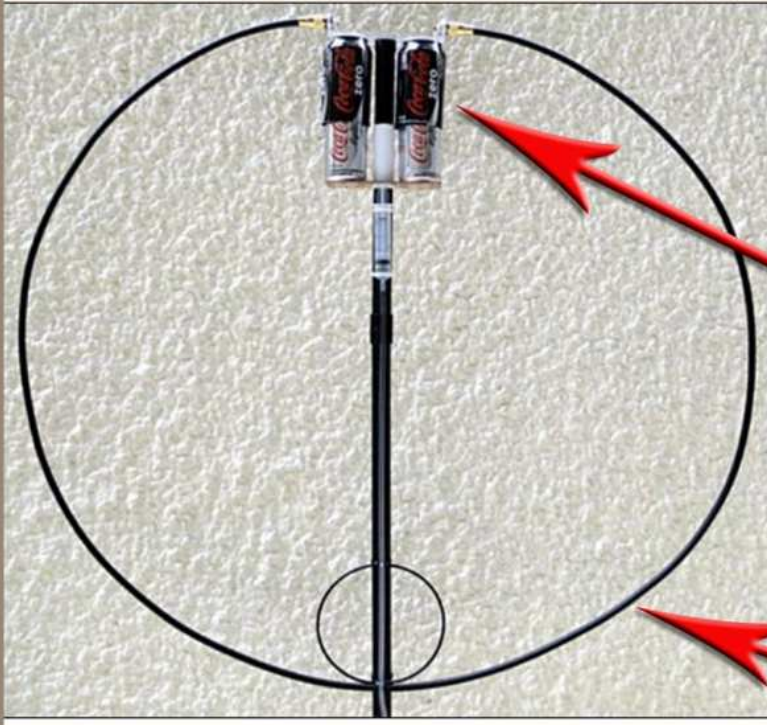


HOME BREW STLs





HOMEBREW STLs



LMR-400 Coax

HOMEBREW MOBLE STLs



HOMEBREW MOBLE STLs

K6HPX



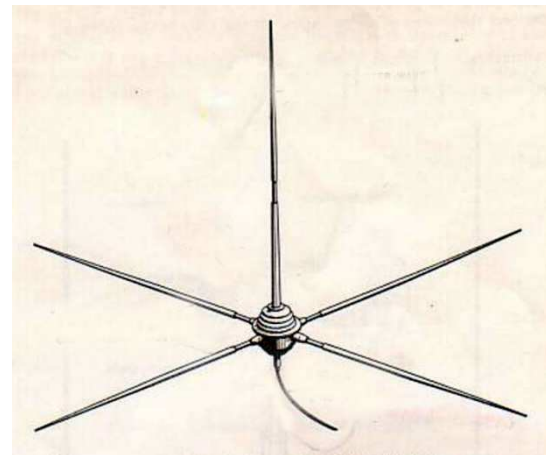
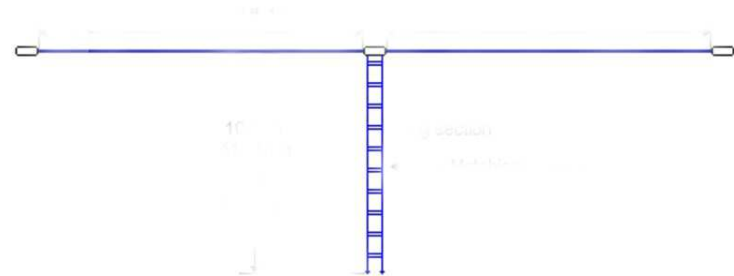
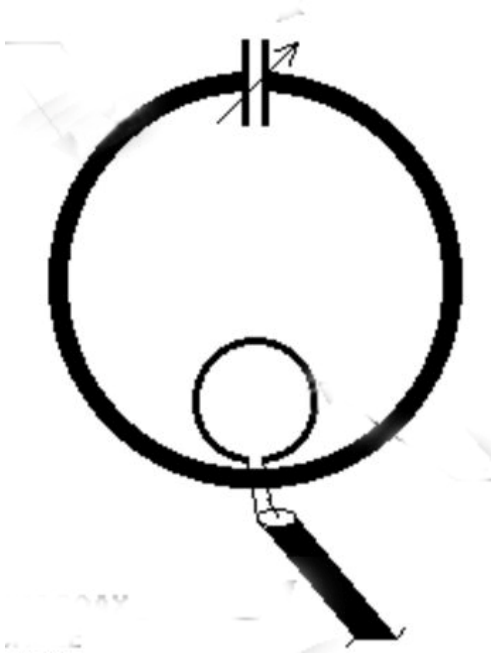
AUDIO DEMO

Compares the following antennas on 10 meter FM from San Jose to Seattle.

- 3' diameter STL in garage rafters.
- G5RV @ 45'.
- 1/4 wave ground plane on the roof.

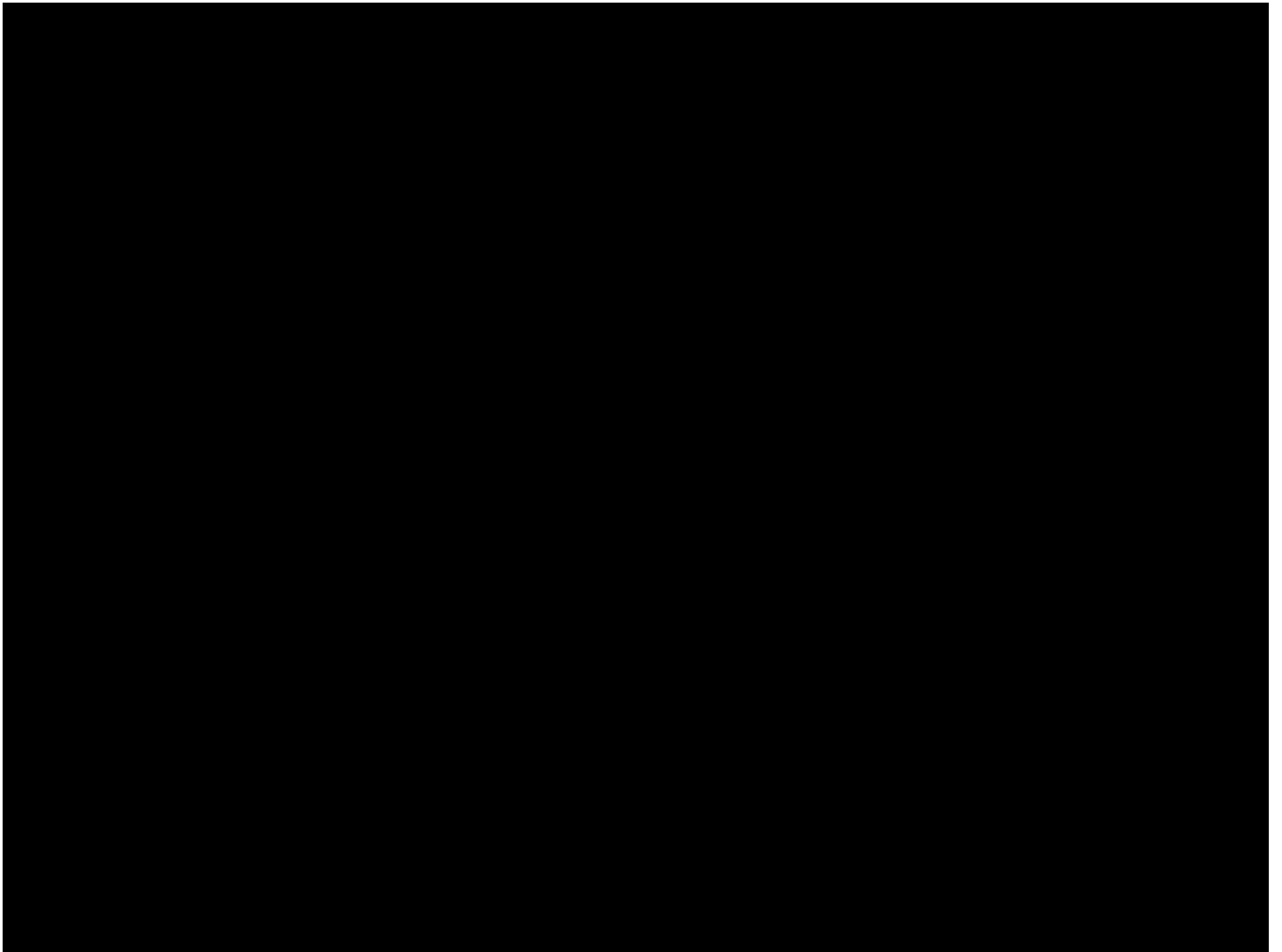
Note: All antennas were the same distance from a very noisy power line.

Antenna Comparisons



VIDEO DEMO

Shows how well an STL works indoors.



REFERENCES

Small Transmitting Loops:

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[QST](#), June 1986 page 33

[QST](#), June 1993, page 32

Loop Calculators:

<http://www.aa5tb.com/loop.html#cal>

<http://www.iw5edi.com/software/magnetic-loop-calculator>

http://www.66pacific.com/calculators/small_tx_loop_calc.aspx

<http://www.zerobeat.net/G4FGQ/page3.html>

QUESTIONS?

