

# Portable Magnetic Loop Antennas

Ham Radio's Best Kept Secret

By: Kurt Eversole – KE9N

# Topics

Why a Small Magnetic Loop?

What is a Small Magnetic Loop?

Build or Buy?

Design Considerations

Building Tips

Operating Tips

# Why a Portable Magnetic Loop?

Can sometimes be used in HOA's or apartments

Extremely fast setup (<5min)

Best designs high efficiency (>80%)

Very easy to design (using online calculators)

Excellent noise null

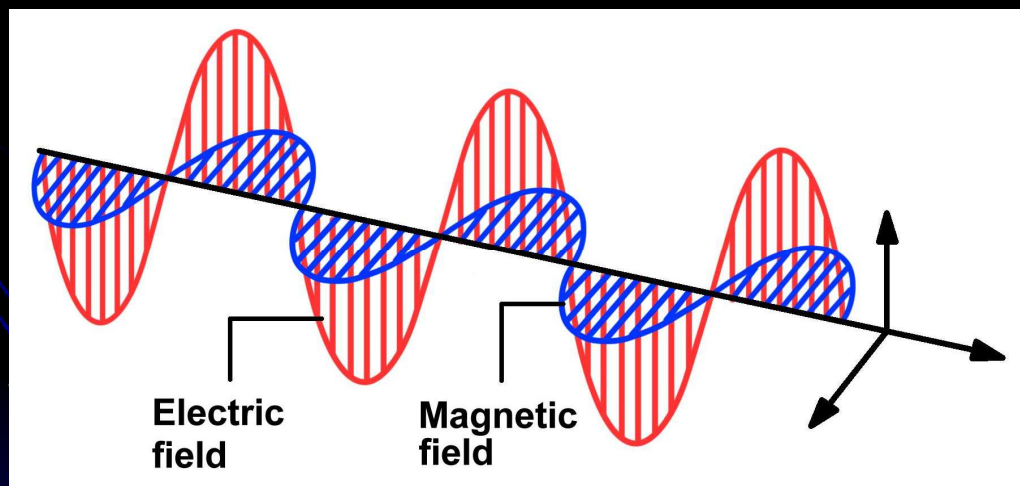
High-Q good for Multi-TX environment

Need only 1 loop diameter above ground

- Resonant - No Tuner Needed
- No Radials or Trees Necessary

# What is a Small Magnetic Loop?

*A magnetic loop* behaves electrically as a coil (inductor) with a small radiation resistance due to its small size. It can be analyzed as coupling directly to the magnetic field. (opposite to the principle of a dipole which couples directly to the electric field)



# Build or Buy?

## Buying

Loops made commercially by Alex, PY1AHD and MFJ, and others.

SML 7-30 well built, and well designed.

Alex's Website is a MUST for loop information.

<http://www.alexloop.com/>

MFJ manufactures a broad range of magnetic loop antennas. 150 watts maximum.

<http://www.mfjenterprises.com/Categories.php?sub=1&ref=53>

# PY1AHD SML 7-30



# PY1AHD WALKHAM



# Building a Loop

Don't be afraid to experiment!

**SAFETY FIRST! HIGH VOLTAGES!**

I mean **REALLY HIGH!**

Use extreme caution if you have any medical conditions, or are using any medical devices such as a PACEMAKER.

Check with your doctor first about exposure to RF radiation.



# Design Considerations

Use online magnetic loop calculators for the design.

<http://www.66pacific.com/calculators/small-transmitting-loop-antenna-calculator.aspx>

AA5TB Excel Program by Steve Yates

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

# Design Considerations—Loop Circumference

Loop circumference must be slightly less than  $\frac{1}{4}$  wave at the highest frequency.

Best efficiency for the loop is it's highest usable frequency.

Loops get increasingly inefficient the lower in frequency they are tuned -  
Just Like a mobile whip.

# Design Considerations—Loop Thickness

Larger loop material = more efficient

Practical considerations:

Minimum - 1/2" OD copper tubing,  
3/4" copper tubing, or hardline.

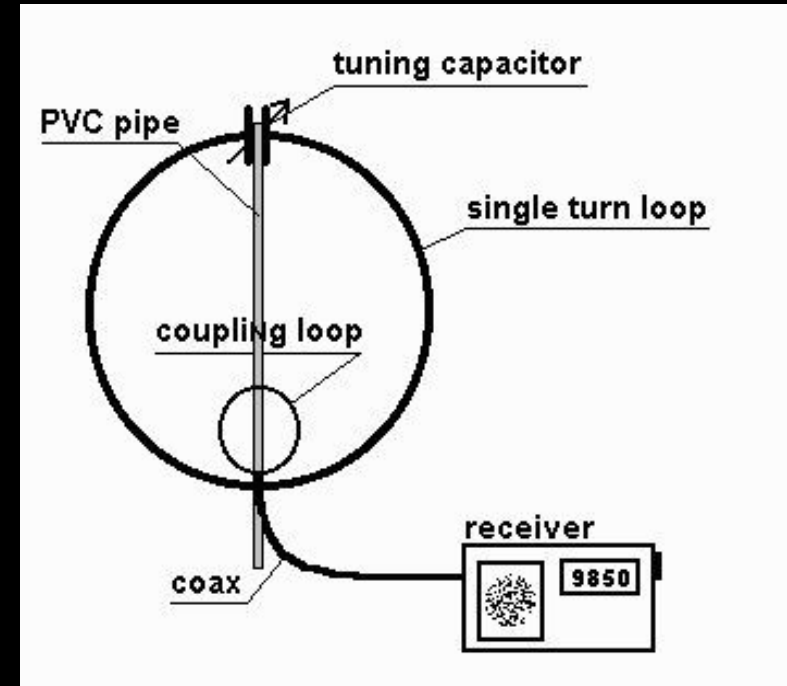
- May be rigid or flexible.
- Two loops fed in parallel
- offer more surface area
- than one single loop.



# Design Considerations—Loop Shape

Maximum area for given circumference is the most efficient.

This means a circle!  
But octagonal, square,  
or other shapes will work.



# Design Considerations—Loop Height

Vertical loops need only 1 loop diameter above ground.

There is no apparent gain from increased height.

- Horizontal loop considerations are the same as a dipole, however their radiation pattern is omnidirectional with an overhead null.

# Design Considerations—Loop Feed

The easiest way to feed a small magnetic loop is with a coupling loop.

1:1 Feed Loop Transformer

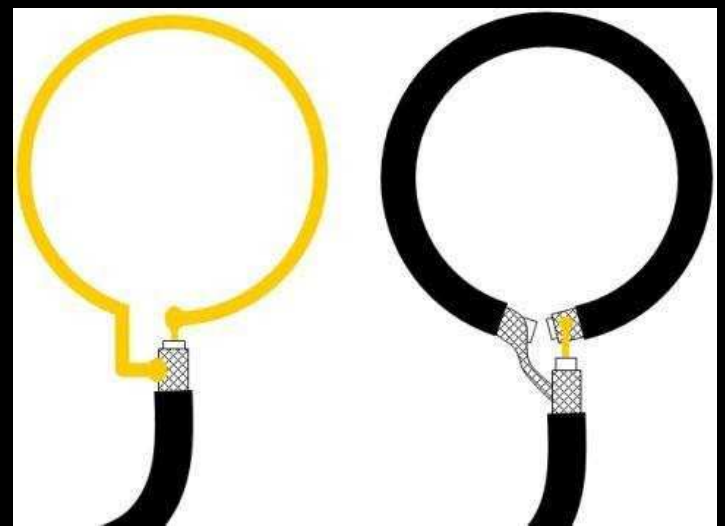
Easiest to build

Easiest to tune for matching

# Design Considerations—Feed Loop Transformer

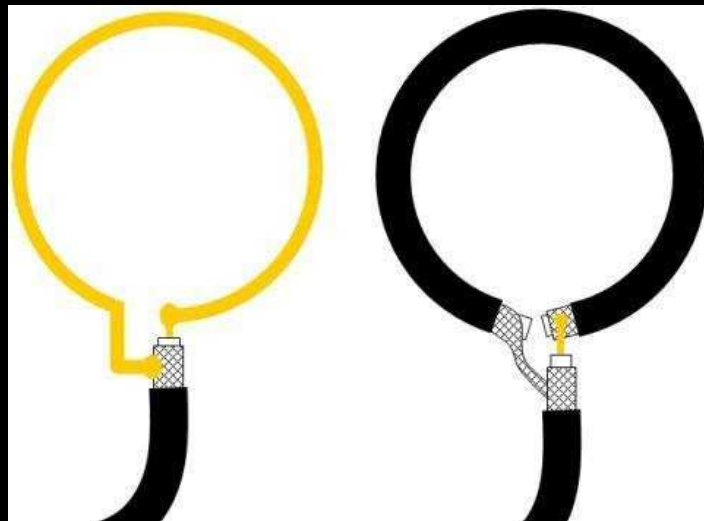
Make the feed loop  $1/5$  the size of the main loop.

You can use large diameter solid copper wire (8 gauge or larger),  $3/8$ " copper refrigerator tubing, or coax.



# Design Considerations—Feed Loop Transformer

Solder the coax braid to one side of the feed loop, and the center conductor to the other side.



- The feed loop must not touch the main loop – space according to voltage.



# Design Considerations—Loop Capacitor

**WARNING: VERY HIGH VOLTAGES!**

Even QRP Radios Can Generate 1000 Volts or More Across Capacitor

100-watt Radio Can Generate a few Kilovolts or more.

- **RF BURNS ARE NOT FUN!**

# Design Considerations—Loop Capacitor

A low loss capacitor means higher loop efficiency.

Butterfly capacitors are good. Use ganged capacitor as split stator to eliminate wiper losses.

Vacuum variables are good

- Higher cost with high voltage rating

- Many turns means finer tuning – wider range

# Design Considerations—Loop Capacitor

## Butterfly Capacitor



Large wide spaced split-stator style air variable capacitor

# Design Considerations—Loop Capacitor

Vacuum Variable

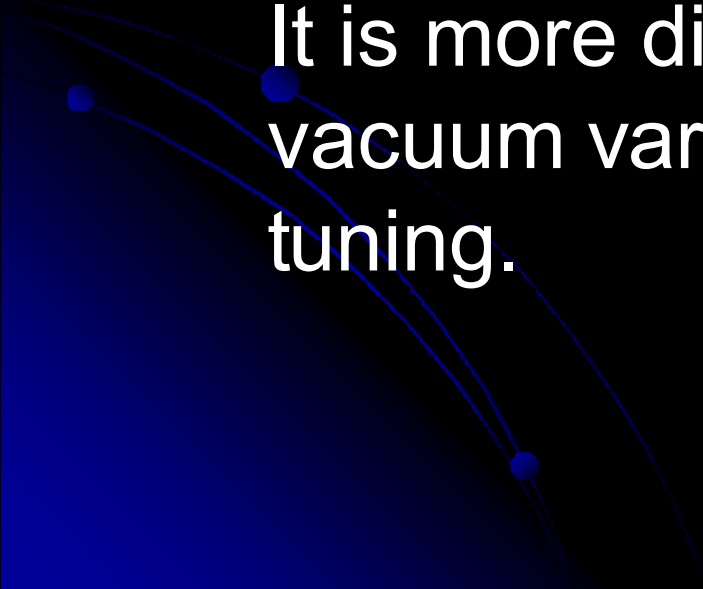


Large kVA rated vacuum variable capacitor

# Design Considerations—Loop Capacitor

A butterfly capacitor can be motorized with a small 1-2 rpm DC motor and control box.

It is more difficult to motorize a vacuum variable, but allows for remote tuning.



# Design Considerations—Loop to Capacitor Connection

Connections must be as low loss as possible.

Use copper braid, such as grounding strap material.

- Compress main loop tube onto the braid and solder.

# Design Considerations

The feed loop or variable capacitor can go at the top of the loop.

The other component goes at the bottom.

- For big loops, it is easier if the capacitor is on the bottom.

# Construction Tips

The radiation resistance is around 1 Ohm or less, so solder wherever possible and use large mechanical joints.

Grounding strap braid works well, but solder the lug connectors!



# Using A Mag Loop in the Field

MAG LOOPS are onlooker magnets!

**WARN visitors of high voltage!**  
**THEY WILL TRY TO TOUCH IT!**

Onlookers will also detune the loop  
by capacitive coupling



# Using A Mag Loop in the Field

For small loops, use a cheap photo tripod.

For larger loops, use a purpose-built non-conductive mast. The mast **MUST** be insulated from the loop.

Elevate the loop one loop diameter

- No advantage to higher loop height

- Keep away from large metal objects like cars, T-72 tanks, B-1 bombers, etc.

# Using A Mag Loop in the Field

## TUNING:

High-Q makes tuning by receiver noise easy and fairly accurate.

Fine tune using low power and check the SWR on the radio.

- **ALWAYS** check SWR before applying full power.

# Using A Mag Loop in the Field

The axis of the loop is the pattern direction

The pattern is a figure-8 shape.

The peak direction is somewhat broad.

The noise direction is somewhat narrow.



# Using a Magnetic Loop How About a Little Automation?

To Automatically tune a Magnetic Loop Antenna  
By :Lofter Jonasson – TF3LJ / VE2LJX

<https://sites.google.com/site/lofturj/to-automatically-tune-a-magnetic-loop-antenna>





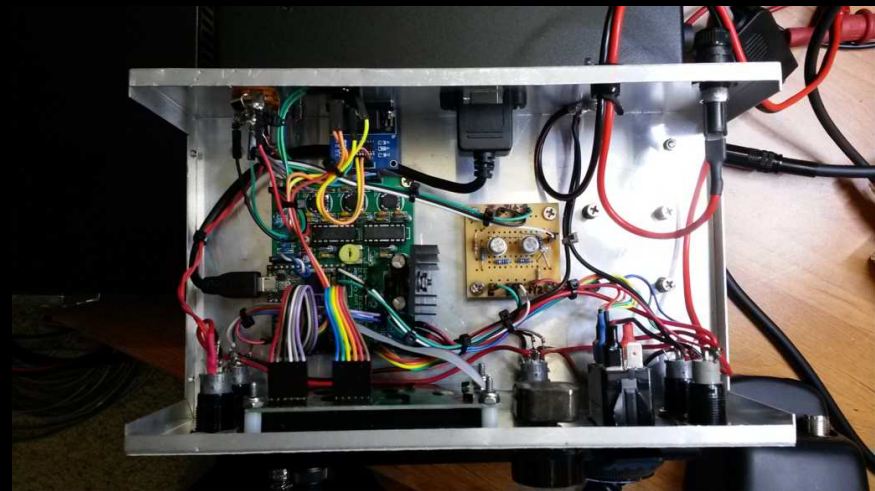
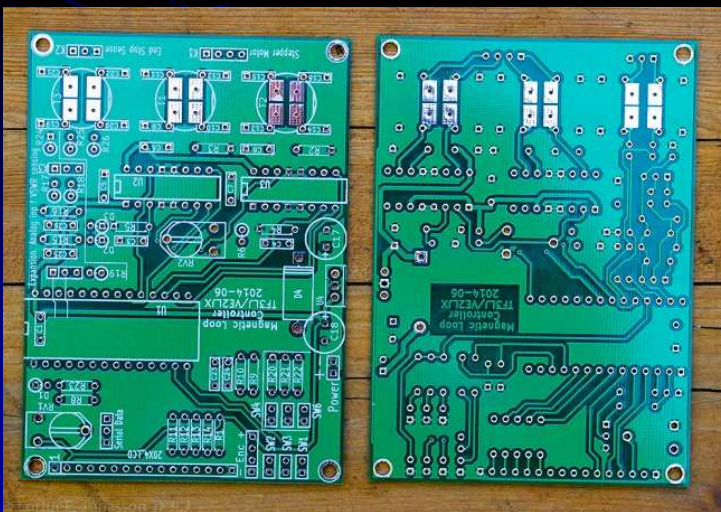
# Using a Magnetic Loop How About a Little Automation?

A circuit board (sheild) is available for \$20.00 (unpopulated) which interfaces to a Teensy 3.2 microcontroller.

Complete BOM of parts required is provided on the website with Digikey part numbers. Everything runs on 12 volts.

A Yahoo group is available for the Magnetic Loop Controller at:

<https://groups.yahoo.com/neo/groups/loopController/info>



# Using a Magnetic Loop

## How About a Little Automation?

The controller reads the frequency of the radio and tunes the loop through the use of a stepper motor, which is connected to the capacitor. The capacitor can be a butterfly type or a vacuum variable.

Radios can be a Kenwood, Icom, Yaesu, Elecraft, and Tentec. The controller reads either TTL or RS-232 outputs, and has a USB passthru port so you can still interface your computer to your radio.

Initial setup and set points are easy to program.

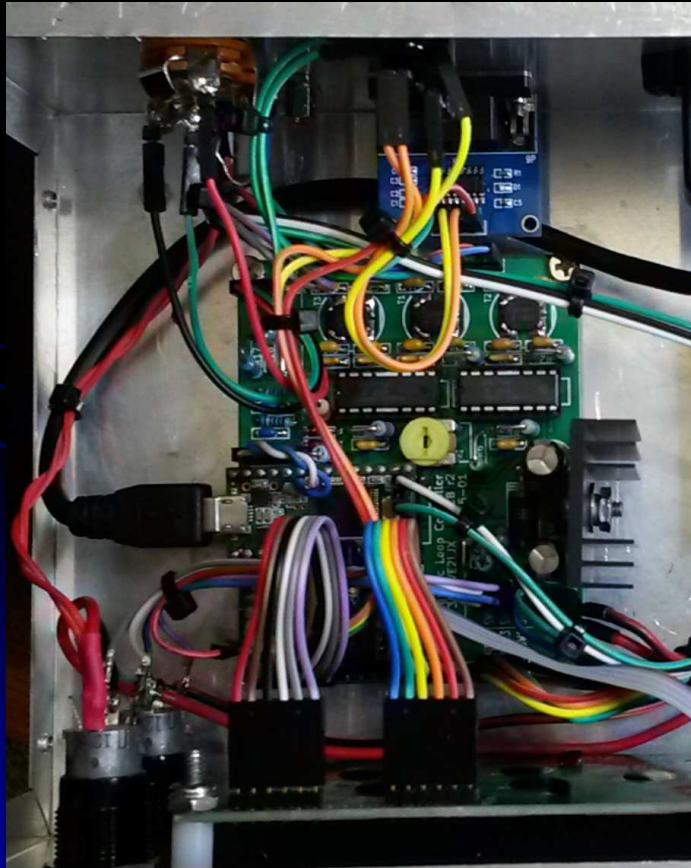
```
Radio: 14.216.000 Hz
Tuned: 14.215.916 Hz
StepP: 1.518 1.518
Range: 3 Motor: Off
```



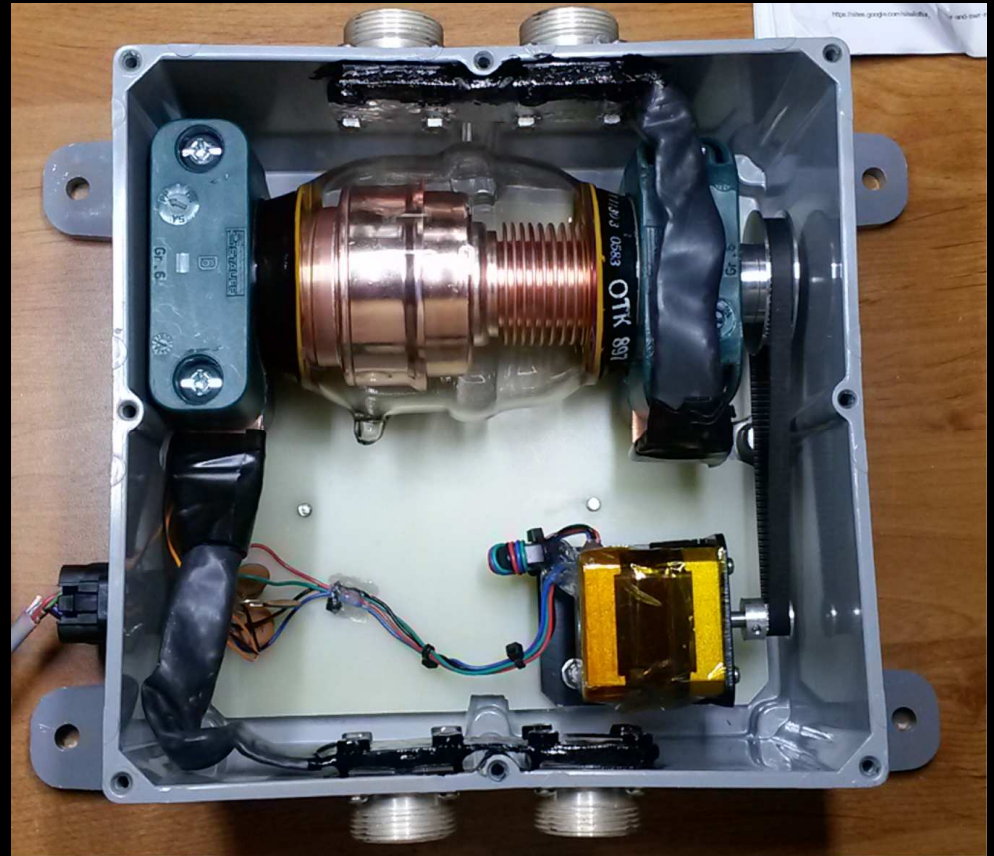


# Using a Magnetic Loop How About a Little Automation?

Inside the control box.



Inside the magnetic loop capacitor box.





# Using a Magnetic Loop How About a Little Automation?

Changing from 20 meters to 10 meters. Click on the picture to the right to watch the display change



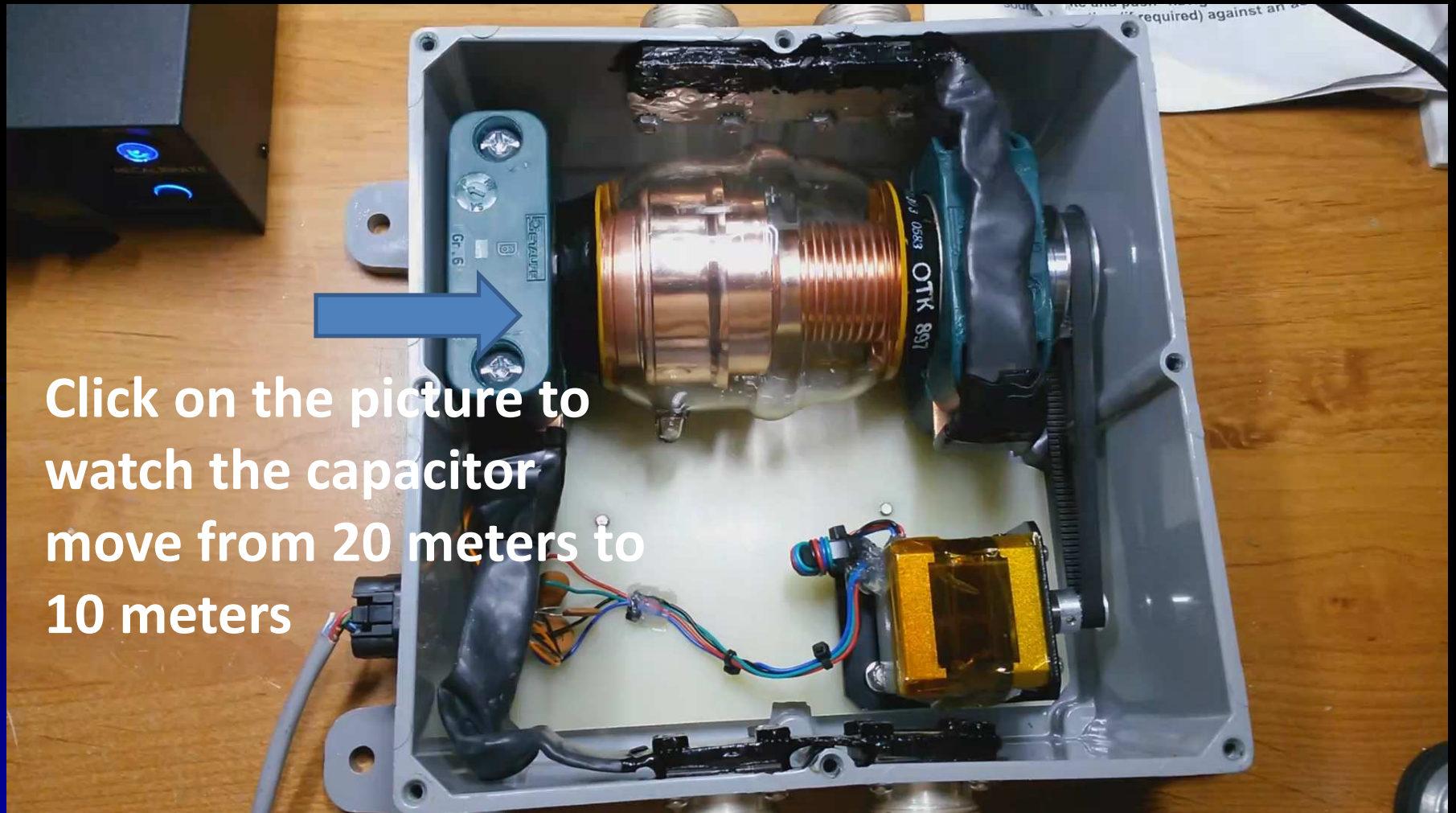
```
Radio: 14.200.000 Hz  
Tuned: 14.199.944 Hz  
StepP: 1.402 1.402  
Range: 2 Motor:Off
```

MAGNETIC LOOP CONTROLLER

```
Radio: 14.200.000 Hz  
Tuned: 14.199.944 Hz  
StepP: 1.402 1.402  
Range: 2 Motor:Off
```



# Using a Magnetic Loop How About a Little Automation?



Click on the picture to  
watch the capacitor  
move from 20 meters to  
10 meters

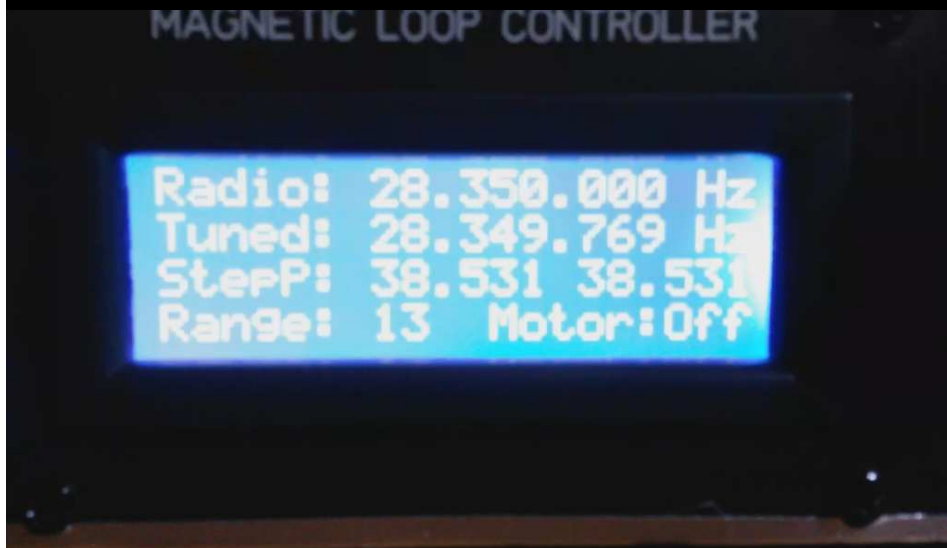
# Using a Magnetic Loop How About a Little Automation?

Click on each picture to view the video.

Going from 10 meters back  
to 20 meters



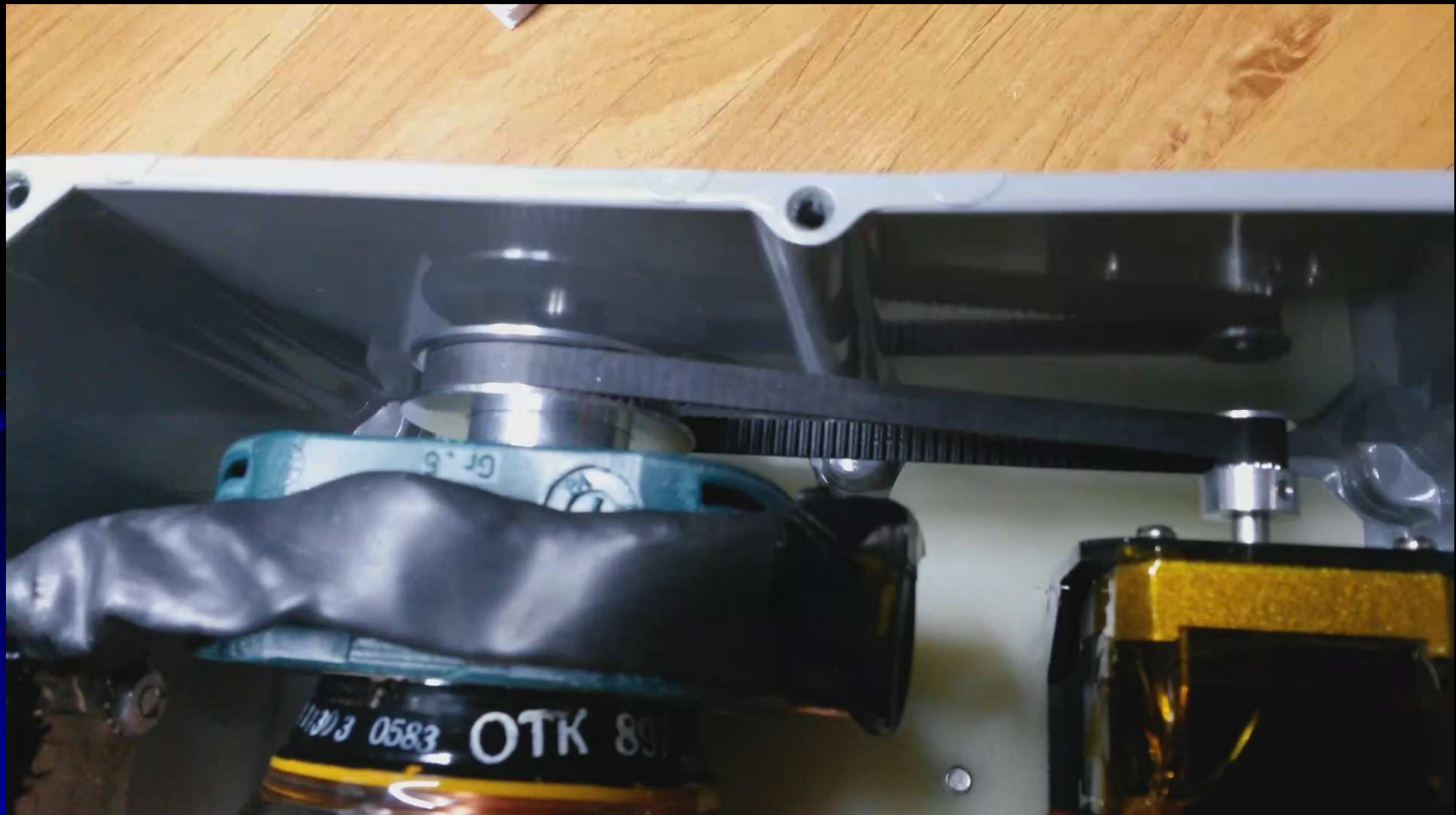
View the capacitor going from 10  
meters back to 20 meters





# Tuning a Portion of 20 Meters

Tuning from 14.200 to 14.225 and then back to 14.200.  
Click on the picture below to view the video. ↓



# Using a Magnetic Loop

## How About a Little Automation?

Options included for the controller are:

Power and SWR monitoring during transmitting.

Automatic or manual SWR tuning.

Speed and torque settings along with backlash compensation for the capacitor.

Automatic antenna switching for different loops used.

# Questions?

## Informational Links:

<http://www.alexloop.com/>

<http://www.mfjenterprises.com/Categories.php?sub=1&ref=53>

<http://www.66pacific.com/calculators/small-transmitting-loop-antenna-calculator.aspx>

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

<https://sites.google.com/site/lofturj/to-automatically-tune-a-magnetic-loop-antenna>

<https://groups.yahoo.com/neo/groups/loopController/info>

# THANKS FOR WATCHING!

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