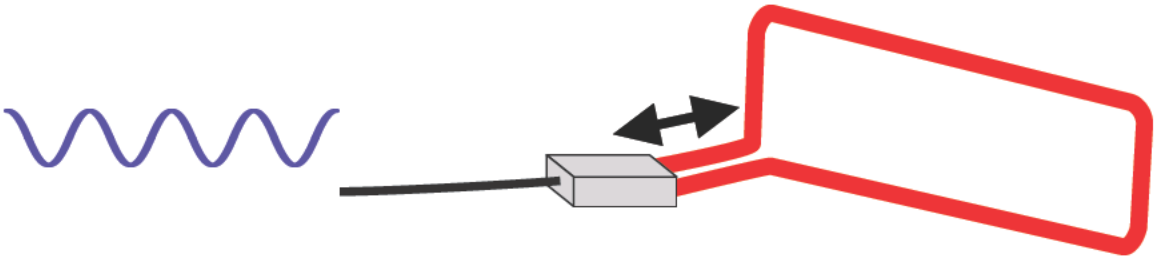
# PIT Tag Antenna
# Design Guidelines

Oregon RFID

April, 2015

PIT Tag Antennas

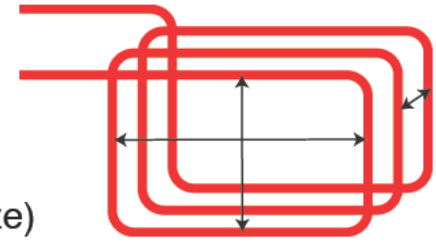
Low Frequency RFID uses magnetic fields and electrical induction to wirelessly charge PIT tags and read their data. The antenna is made from a loop of wire that generates a magnetic field. Capacitors are attached that cause the magnetic field to oscillate between north and south.



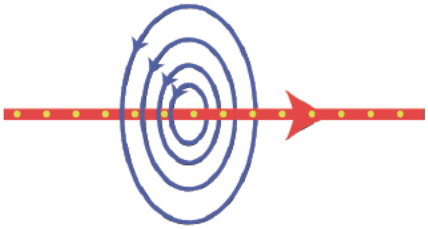
A PIT tag antenna generates a magnetic field to charge tags and be sensitive enough to hear the response. Finding an antenna that has the proper tradeoffs requires trying different alternatives to find which design will perform best.

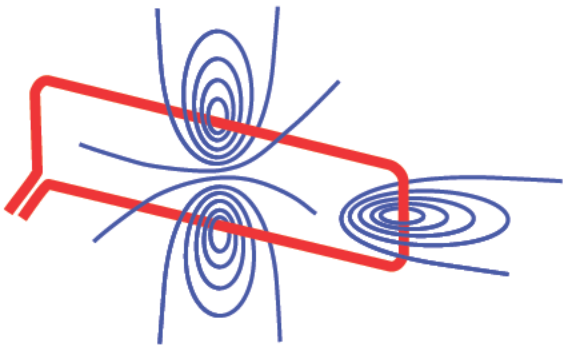
The physical parameters for an antenna are

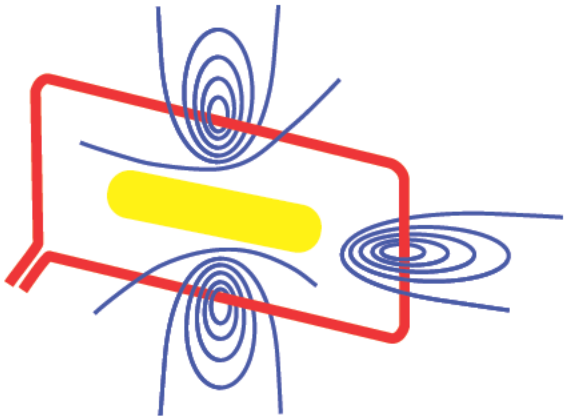
- height/width or diameter of the loop
- number of turns of wire in the loop
- the spacing between loop turns
- wire (size, number of strands, strand size)



Magnetic fields surround the wire but the distances are very short compared to radio signals. This usually means one axis must not be very large or there will be a hole in the middle of the field.

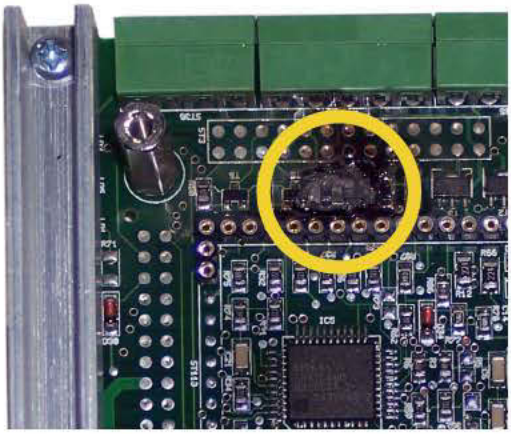






## The effect of wire size

The choice of wire is important since it controls the power level of the resonance that builds up in the antenna. If the wire is too thick, very high voltages can develop which can damage the electronics. If the wire is too thin, the antenna performance will be limited.



Burn hole from excessive voltage developing on the antenna

The antenna power level is based on the ratio of inductance and resistance, both controlled by the wire. The inductance is primarily determined by the size of the loop and the number of turns of wire. The wire length and characteristics (size, stranding) determine the resistance. Adding turns to a loop increases the inductance to generate a stronger field but at the same time requires a longer wire which adds resistance to weaken it. The goal is to find the proper balance.

Thin wires are used for small antennas while thicker wire with lower resistance are used for large ones. The height of the loop will depend on the antenna wire, turn spacing (if multi-turn), the reader supply voltage, the length of twinax and site conditions (noise, metal).

## Wire size and stranding

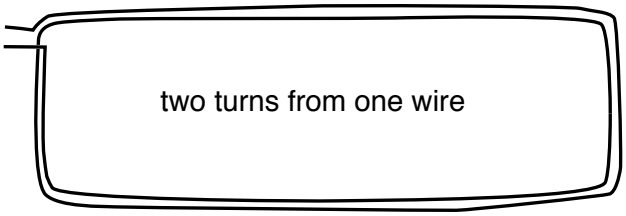
Wire size and stranding affect antenna performance. In the US, overall wire size is specified in American Wire Gauge (AWG). A solid wire is electrically different than a stranded wire of the same gauge. For a given gauge there are different standings available. A chart of common antenna wire sizes is at the end of this document.

Wire size guidelines

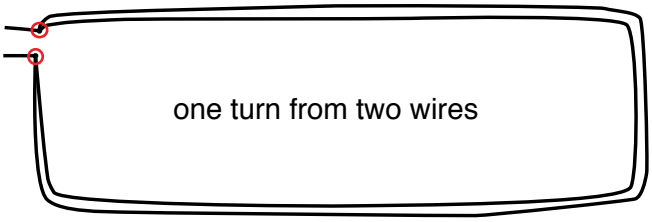
For HDX antennas over 30 feet (10 m) wide, the antenna will usually be a single turn of wire. Antennas over 100 feet wide (30 meters) are made from thick fine stranded welding cable such as AWG 1/0 (105 mm2).

Wire sizes from 4 to 8 gauge are used for antennas under 100' wide. An inexpensive large antenna can be made from heavy duty electrical extension cable. One cable can be used to make a 45' wide loop. Two cables can be connected together for twice the width.


HDX antennas around 30' wide are at a transition point between one and two turns. Multiple turns are usually necessary with loops under 30' (10 m) wide.




A good antenna around 30' wide uses two 10 AWG (105/30) wires in parallel (boat wire).

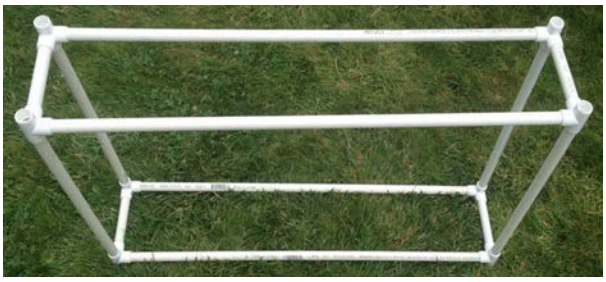



The choice of antenna wire becomes more critical with smaller diameters. For antennas under 15 feet, the proper the number of turns is found by comparing the performance with 3 and 2 turns of wire sizes between 8 and 14 AWG to see which reads best.

For the smallest loops under 2' diameter, compare 5, 4 and 3 turns using wire from 16 to 22 AWG.

Turn Spacing

The spacing between multiple turns can make a big difference in antenna performance. A winding frame he helpful for developing multi-turn loops to adjust the number of turns and spacing to search for the optimum position. The inductance will change with the spacing so the antenna must be re-tuned after making adjustments.




Once the spacing has been found, corrugated plastic can be used to build the antenna. It is available as a vinyl sign material (Coroplast®) that can be cut with a knife or durable polycarbonate sheets (Polygal®) used for greenhouses that is cut with a saw.

Compound wire can be used to form multiple turn loops with controlled spacing.

Speaker wire is usually twinned

Boat wire has insulated wire within an outer sheath

Compound wires can be made by painting with PlastiDip

# Common wire sizes for low frequency HDX antennas

| | AWG | Number of Strands | Strand Diameter (in) | Straand Diameter (mm) |
|---|---|---|---|---|
| Welding | 1/0 | 990/30 | 0.01 | 0.25 |
| Power | 4 | 750/32 | 0.008 | 0.20 |
| Power | 8 | 650/36 | 0.005 | 0.13 |
| Power | 10 | 418/36 | 0.005 | 0.13 |
| Applicances | 10 | 109/30 | 0.01 | 0.25 |
| Buildings | 10 | 19/23 | 0.022 | 0.56 |
| Audio | 12 | 165/34 | 0.006 | 0.16 |
| Buildings | 12 | 19/25 | 0.018 | 0.45 |
| Buildings | 14 | 19/27 | 0.014 | 0.37 |
| Dog fence | 22 | 7/30 | 0.01 | 0.25 |
| Dog fence | 22 | 1 | 0.025 | 0.643 |