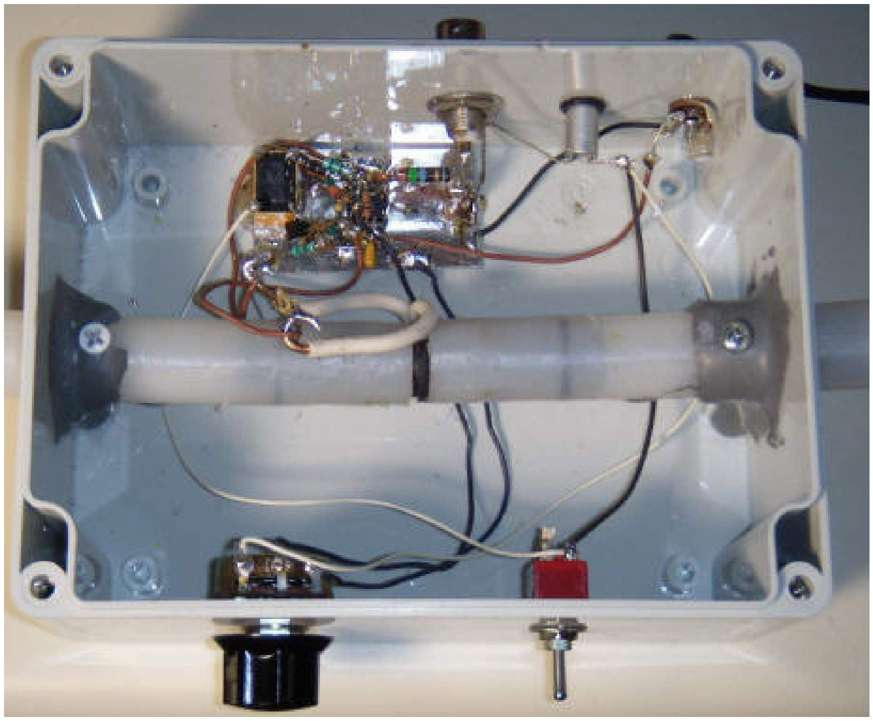
Active 3-30 MHz Hula-Loop Antenna for Shortwave

In the past, designs that incorporated an amplifier in the antenna were called "antennafiers" so perhaps this is a "loopifier". The differential amplifier solves matching issues and the varactor tuning gives excellent out-of-band rejection for even cheap receivers. I think the good common-mode rejection from the differential amplifier eliminates the need for a shield, too.



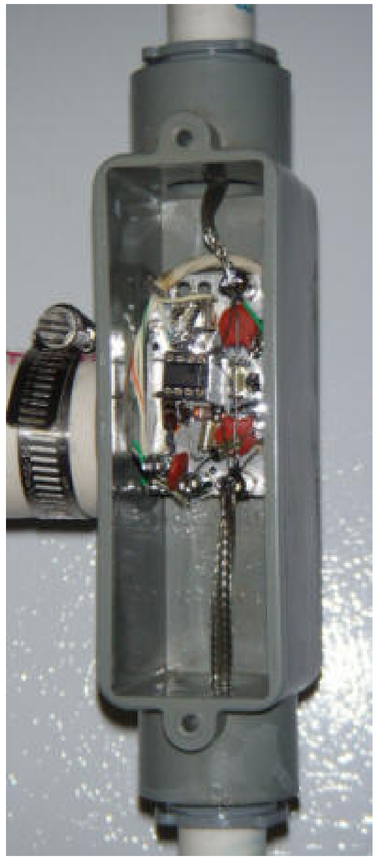
This active antenna for the shortwave band provides surprising performance, even indoors. As the name implies, the main loop is made from a Hula-Hoop with the metallic paint stripped off and a single turn of 14AWG copper wire inserted inside the hoop. (There isn't any need to remove the paint; mine was flaking and I didn't like the looks. Half-way through I regretted my decision!) These hoops are basically thin-walled plumbing tubing with a water-tight connector holding the ends together. (Mine was actually filled with water to make a "swish-swish" sound, supposedly.) The ends of the hoop pass through two holes in a plastic project box and are then joined together. A hole was drilled in the middle of the original black tubing connector to bring out the ends of the insulated house wiring (heavy white wires). This single turn of wire has about 4 uH inductance. A couple of screws and some epoxy holds the loop in position. The screws were added as an afterthought, cracking the epoxy a bit, because the epoxy doesn't really adhere to the tubing very well. The solid copper house wire is too stiff to connect directly to the circuit so a couple of lengths of hookup wire were added. A little piece of tinned copper circuit board material holds the circuitry. The power is supplied by a molded power supply not shown.

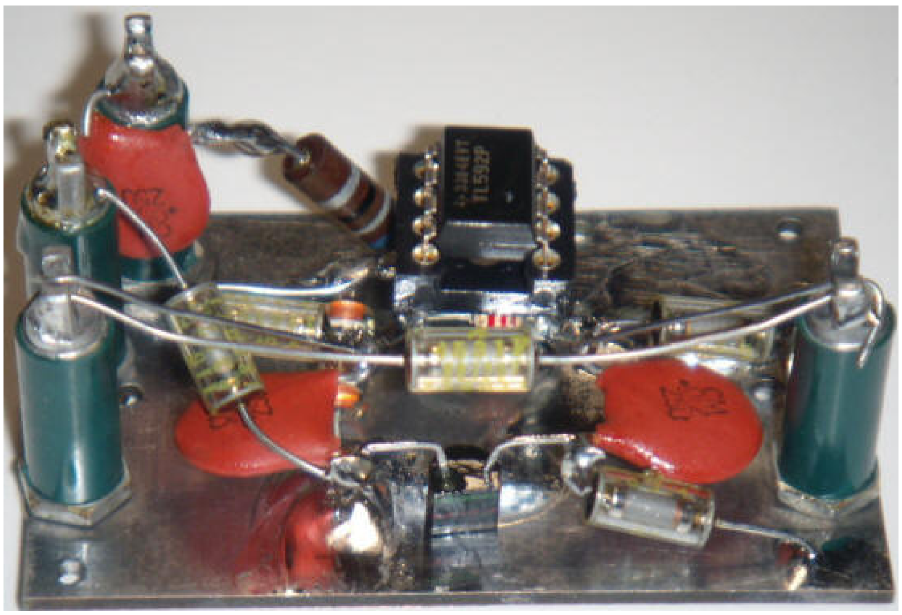
The circuit avoids matching issues by employing a high impedance differential amplifier (TL592) connected directly across the loop. Even with the Q-killing 4.7k resistor, the impedance transformation is on the order of 100:1, an impractically high value for a broadband balun of reasonable cost! Even though the TL592 isn't the lowest noise amplifier ever designed and the resistor kills some of the signal, this configuration picks up so much signal that the circuit noise contribution is negligible! In fact, the amplifier is operating at a very low gain simply to avoid clipping and most signals push the signal meter well over S-9. I've never heard so many stations! The picture to the right shows the signal strength with the antenna tuned to WWV at 10 MHz with the antenna and receiver sitting on the kitchen table. That beats the nice vertical on my roof. Don't be misled, however; the antenna doesn't perform miracles. The atmospheric noise is also amplified so the signal-to-noise does depend on the location of the antenna and other conditions. Nevertheless, this indoor antenna has consistently outperformed my rooftop whip and when moved outside, it "blows away" the rooftop antenna, in some cases giving a strong signal when the whip gave no discernable signal at all. (Without the Q-killing 4.7k resistor across the coil, the bandwidth was only 10 kHz at 5 Mhz. That's a Q of 500! There might be some future projects that take advantage of that.)

The indoor unit in the first photo combines both the "Antenna Unit" and "Base Unit" in one box .

Tuning is accomplished by an AM-band varactor like the MVAM115 or MVAM125. Suitable substitutes include the KV1560 or KV1520 but the potentiometer voltage must be reduced to avoid exceeding those diode's ratings. A 100k in series with the top pot connection should do the trick. Varactor tuning is recommended because longer leads for a mechanical capacitor may add resonances at FM frequencies, causing overload of the amplifier and nasty intermodulation at the output. The varactor should be kept close to the amplifier input leads to minimize the impedance at high frequency. A band switch activates a relay that connects a choke across the main coil for tuning above about 12 MHz. The schematic shows a 1 uH value but the best value will be determined by the choice of varactor and the tuning voltage range. My Hula-Hoop prototype above has two, 1 uH chokes in parallel to just reach 28 MHz but the square loop required 1 uH to tune to 30 MHz. It is pretty easy to tell where the antenna is tuned by observing the noise peaking on the receiver's S-meter. The original experiments were done at 15 volts and the extra voltage pushed the frequency to well over 30 MHz but I dropped down to 12 volts since 12 volt relays and power supplies are more common. The low end of the range is about 3 MHz and there is plenty of band overlap.

An outdoor version was built with ordinary PVC tubing in a square shape similar in dimensions to the Hula-Hoop (not critical). The stiff 14AWG copper wire was replaced with a heavy braid to make it easy to thread the wire through the square shape. The circuit is identical except that the potentiometer and band switch are in a separate box near the receiver (little white box) and a 4-conductor wire caries the DC signals to the remote antenna box (a PVC electrical junction box).





The relay was added after the photos of the outdoor box and board above. The wires coming down from the antenna include a cable with four-conductors to control the amplifier, a coax cable for the RF to the receiver, and a three-conductor cable for the antenna rotator.

The performance of the indoor antenna is good, moved outside on a flipped-over garbage can it is great, but the performance of this rooftop loop is spectacular! Simply tune the radio to the desired frequency then tune the antenna for maximum noise, switching the band somewhere around 12 to 15 MHz. (there is plenty of overlap). The Q is low enough that retuning is only necessary when moving from one band to another. In some areas lower Q may be desired to prevent amplifier overload. In only a couple of days I've heard stations all over the world including some "numbers" stations with S9 clarity!