Remote control of a magnetic loop variable capacitor

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I use two magnetic loops as my main antennas because I live in a retirement centre where large visible antennas are not allowed. Also each free standing house has just one meter of ground around the house, too little space for antennas. Each house has a small walled back yard where the dustbin and washing lines are situated, so the loop antenna can be installed there although it is far from ideal. One of my antennas stands in my garage but I plan to dispose of it because the noise level is higher indoors.

But in spite of these limitations, I still receive quite well although I suspect that my antennas are lossy on transmit because I struggle to make two way contacts. Using the FT8 mode I can receive signals form all over the world, as far away as Korea, Indonesia, North and South America, Europe, all over, especially on 40M and 30M.

I made the mistake of using copper strip wound spirally around PVC pipe for the one antenna, forgetting that RF prefers to flow along edges of the strip, making the antenna a lot less efficient. The other antenna uses aluminium strip, an equally bad decision. New antennas are planned using W6NBC's methods. There is a presentation on Youtube by him.

MFJ control their loop antenna's butterfly capacitors by sending DC through the coax cable, but I am not sure what circuit they use. I had no problems obtaining a small DC motor with gearbox from the Chinese, and I could vary the speed by simply reducing the voltage. But this did not work well on low voltages, so I decided to control the speed by using Pulse Width Modulation which is a recognised method of speed control for DC motors.

I made up a temporary system for test purposes and attached a spare motor to it and found that I could not notice a difference in torque by simply holding the shaft, from low speeds to full speed while varying the PWM from zero to full scale. This is of course not a very scientific way to do it, but it was the best I could do. I did a lot of reading about it and it seems like a reduction in torque would occur at low speeds but not as bad as when you reduce the DC supply to the motor.

I also experimented with the frequency of the PWM, and found that when using a frequency in the audio range, it made a noise on my radio which drowned out the audio from the radio so that it was difficult to hear when the antenna resonated, so I adjusted the frequency to about 20kHz without affecting the torque. But the noise was still there, due to the quick rise and fall times of the PWM waveform. But a 100 nanoFarad capacitor across the motor terminals in the control box, fixed that problem and the system works very well now.

The circuit is in a metal box that I salvaged form a previous project, with a mains powered power supply that produces about 16V DC. The motor is a 12V one, but the average power is way less that a 12V supply would provide because of the PWM. Current is 40mA on no load, rising to about 60mA when I try to hold the shaft.

A key component is the L298 H-bridge breakout board. This is a component that is used to control either two DC motors, or one stepper motor. It costs from about R40 to a good deal more depending on where you buy. Apart form the power supply, it also needs a PWM circuit that can be easily constructed using the popular LM555 integrated circuit.

I designed a circuit board on which I mounted all the components but the circuit is not so complicated that it cannot be constructed on strip board. I am happy to supply details of my board if anyone wishes to use the design.

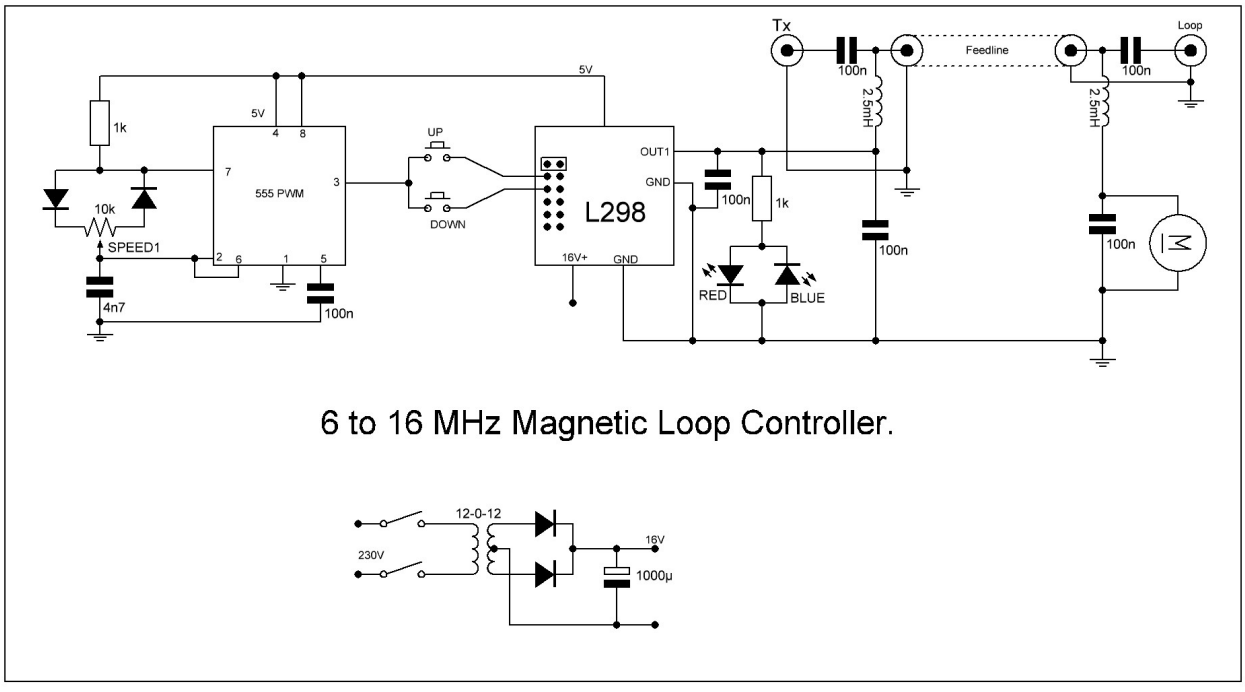
Now something about the loop antenna: There are some beautiful designs on the web, many of them I suspect will perform badly, especially on transmit because of a poor choice of conductor. W6NBC pointed out that the key to efficiency is to use a large diameter round conductor. He suggests PVC tube of large diameter, covered by aluminium strip in the form of flashing used in roof construction and which is locally available at hardware stores. I have not used it yet, but I intend to do that soon.

There is a Magnetic Loop Calculator on the web, at 66pacific.com, and this tells you what the efficiency of a loop will be if you use small diameter conductor. I plan to try 50mm tubing if it is available for a 10 to 30MHz antenna. I imagine the flashing has adhesive on one side, and this will perhaps not conduct well, one will have to see what can be done about this.

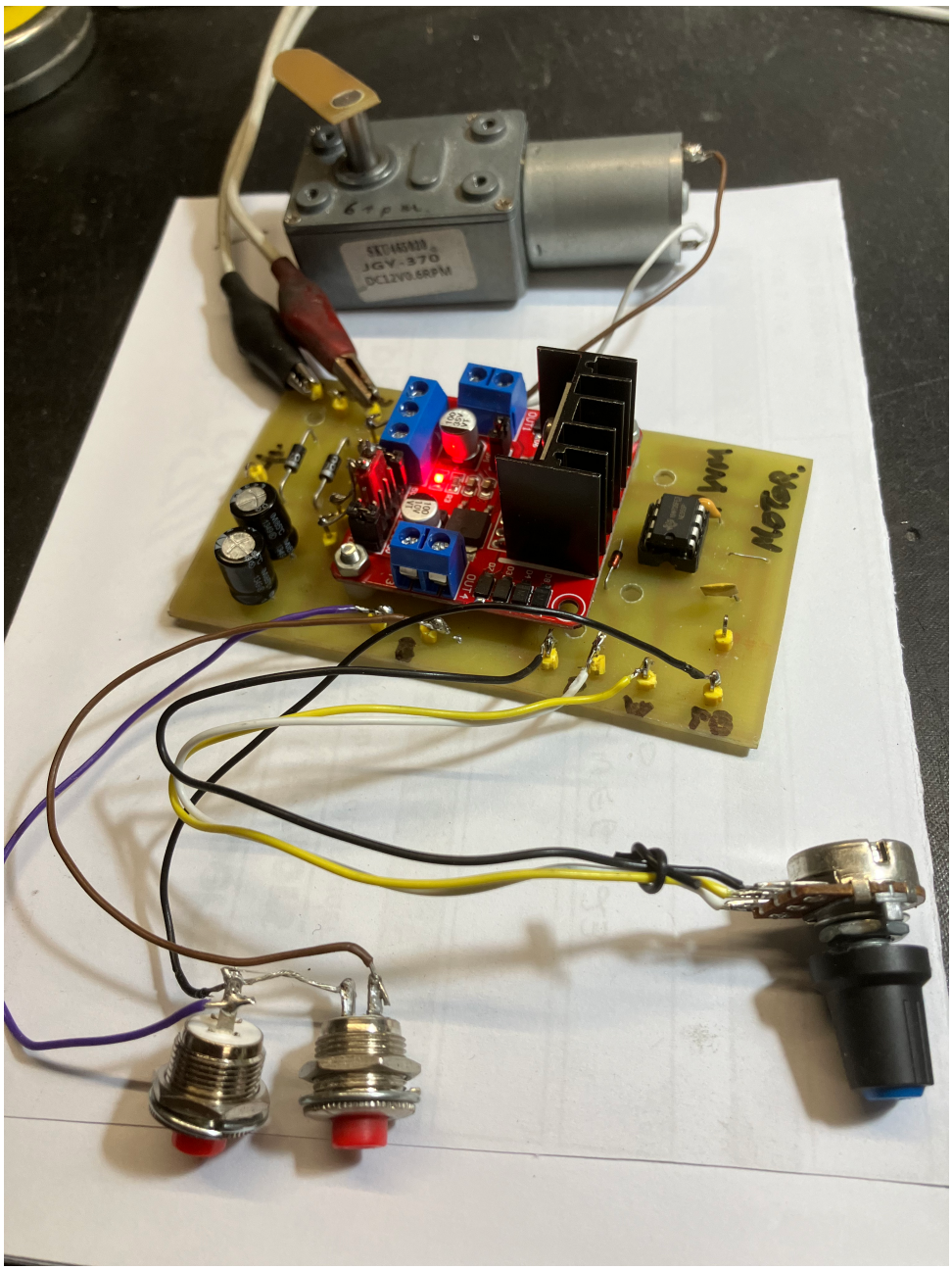
There is another problem that I often see, and this is the use of a trombone capacitor using copper pipe. I think what is forgotten, is that if you slide a trombone capacitor out to increase the frequency of a loop, the capacitance of the trombone is reduced, but the overall length of the loop is increased, which lowers the frequency of the loop. This can be solved by using a short fat trombone, like Alex of Alexloop fame did using Coke tins that slide into each other. There are many of his videos on Youtube.

Then the capacitor: The vacuum variable capacitor is a popular choice and my one loop uses one but the second loop uses a butterfly capacitor. The problem with the vacuum capacitor is that it is difficult to find, and expensive to buy, and they need many turns of the shaft to go from the low to the high capacitance end. For a remote control system one needs some sort of a turns counting system, or a system that measures SWR or a controller with a memory that knows what the position of the capacitor is. One such system is available on the web, by Loftur Jonasson, TF3LJ, but there are many more.

The butterfly capacitor is also hard to find, so I decided to make one myself. There are people on the web that make plates and sell them, but I have a relative who has a business where he can cut plates out of aluminium sheet and I designed the plates and he cut them for me, very good quality, but a bit pricey. A butterfly capacitor does not need end stops, so it can be turned through 360 degrees and there are no problems.



6 to 16 MHz Magnetic Loop Controller.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