**PIT Tag Antenna Design – Supplement to Charney et al. 2007 (*JWM*)**

The basic setup that we employed consisted of four main components: the PIT Transceiver; a switching circuit; tuning boxes; and antennae (Fig. 1). Several different companies sell ready-made PIT transceivers, and the choice of transceiver constrains the rest of the setup. In this study, we designed antennae for two different types of PIT transceivers: a Destron Fearing (St. Paul, MN) FS1001A full duplex transceiver ("Destron") powered by two 12-volt batteries, and a set of Texas Instruments (Dallas, TX) Series 2000 half duplex transceivers ("TI-RFID") powered by a 12-volt battery.

For coarse tuning in the Destron setup, we attached a set of capacitors in series with the transceiver. We accomplished fine tuning via a tuning box built in to the Destron transceiver. Texas Instruments sells separate tuning boxes which we employed in tuning the TI-RFID setup.

The physical dimensions of PIT antennae are typically constrained by decreasing performance (lower read range) as size increases. To double the effective antennae lengths, we placed two antennae end-to end, and installed a switching circuit to rapidly alternate between the two antennae (Figures 1 – 3). The two antennae wings functionally become one antenna in our setup. The switching circuit consists of two single-pole-double-throw solid state relays controlled by a 555 timing chip. The switching frequency is controlled by a resistor-capacitor combination.

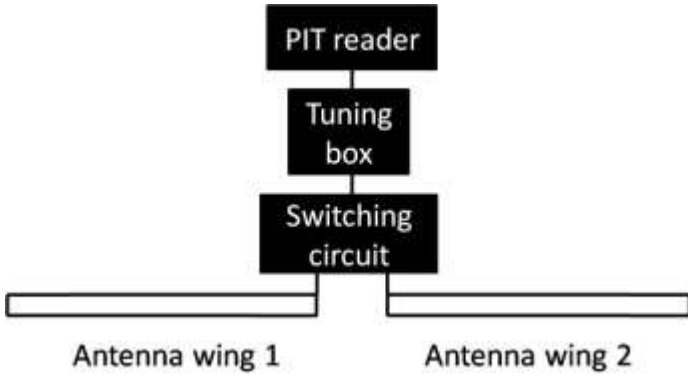


Figure 1. Basic antenna setup employed in our study.

To construct the Destron antennae, we used 18-gauge lamp wire, which consists of two lengths of stranded copper conductors molded together in a plastic coating. For each antenna wing, we placed two 38-m lamp wires parallel each other 0.2 m apart (Charney et al. Fig. 2a). We connected the appropriate conductors so that each wing contained two current loops with a total inductance of 305 $\mu$H. Closed cell polyethylene foam cylinders (inner diameter = 0.01 m, outer diameter = 0.03 m) designed for insulating water pipes wrapped around the lamp wire reduced the capacitive coupling between the wire and the ground. We staked the antennae to the ground with short lengths of 14-gauge galvanized steel.

Each wing of the TI-RFID antennae consisted of 16-gauge lamp/speaker wire forming a single loop of wire 65 meters long and 0.05 m wide (Charney et al. Fig. 2b). We left 10 meters free at the ends of the TI-RFID antennae so that we could adjust the inductance for fine tuning.

In both antennae setups, we gathered local sticks and laid them perpendicular to the antennae every 0.15 meters, giving the antennae the appearance of miniature rail-roads. The sticks guided salamanders so that the PIT tags were optimally oriented for detection when carried across the antennae.

For details on electromagnetic theory governing PIT antennae, see appendices A and B in Charney (2011).

**References**

Charney, N. D. 2011. Movin' & Groovin' Salamanders: Conservation Implications of Large Scales and Quirky Sex. Ph.D. dissertation, University of Massachusetts, Amherst, Massachusetts. http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1367&context=open_access_dissertations

Charney, N. D., B. H. Letcher, A. Haro, P. S. Warren. 2009. Terrestrial Passive Integrated Transponder Antennae for Tracking Small Animal Movements. Journal of Wildlife Management, 73:7, 1245-1250. http://onlinelibrary.wiley.com/doi/10.2193/2008-096/abstract

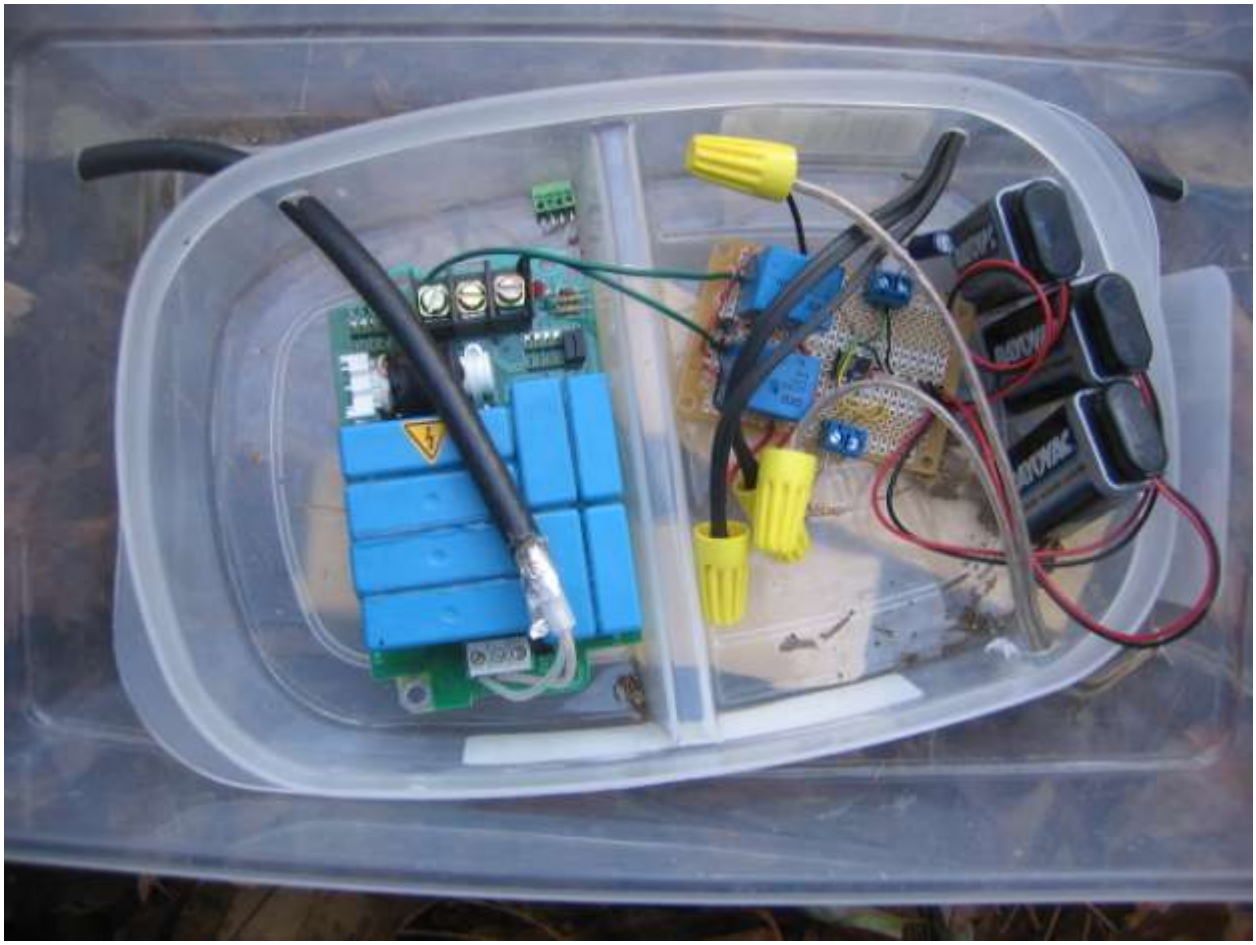

Figure 2. HD Switching setup. Left side are tuning capacitors, and lead to readers, right side is switching circuit and leads to antennae.

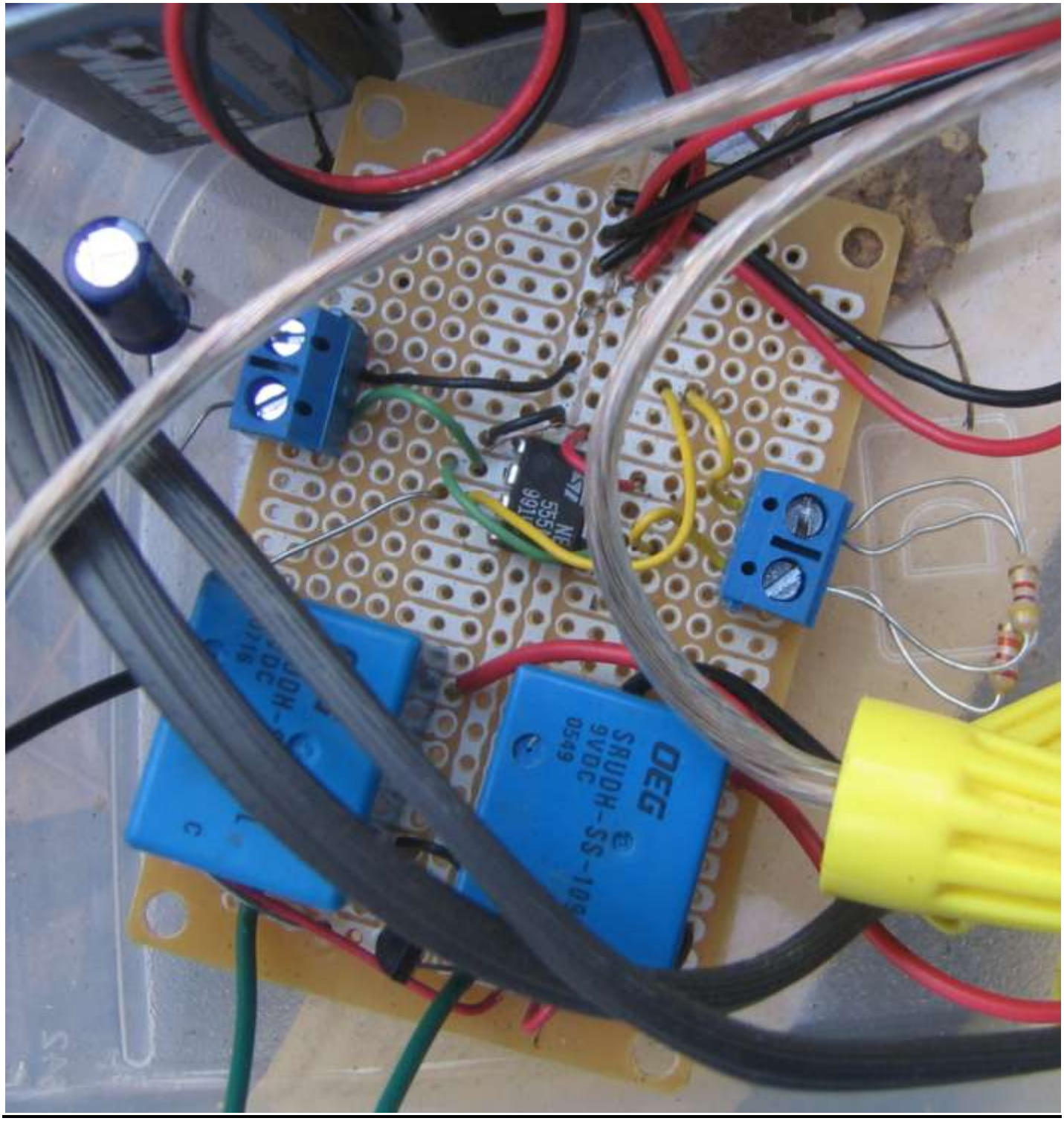


Figure 3. Close up of switching circuit.

Figure 4. HD Reader setup.

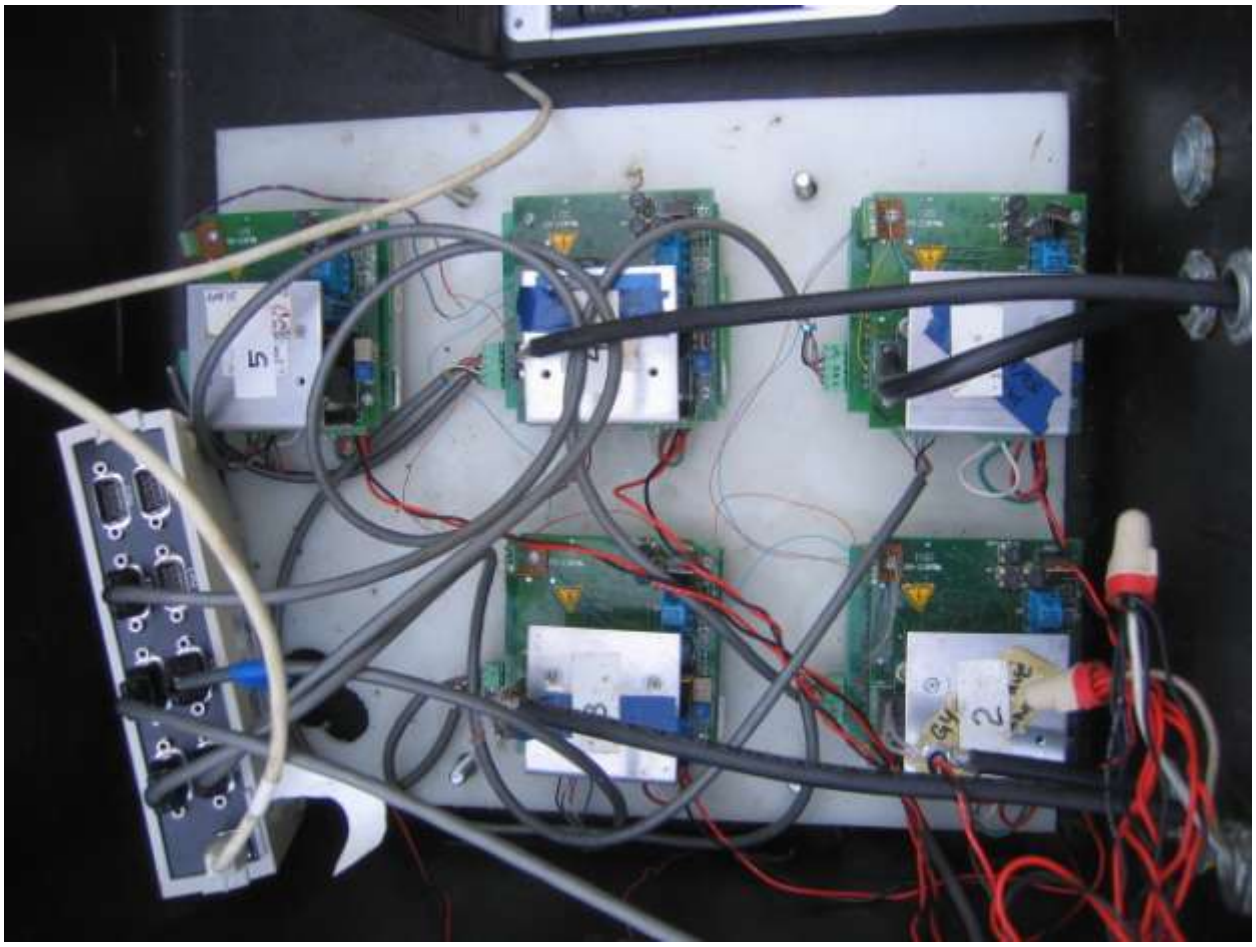


Figure 6. HD Readers.


Figure 7. A single HD Reader