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# A RADIO-FREQUENCY BEACON TRANSMITTER FOR SMALL MAMMALS

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**Abstract:** A lightweight (2.4 grams with 8-day battery), short-range (90–200 feet), radio-frequency beacon transmitter is described for use on small mammals that have limited ranges. The unit does not contain a tuned antenna, and collar size is not critical. In preliminary tests with 12, 15- to 25-gram rodents, locations and individual body movements could be detected.

Many small mammals have restricted ranges because of their size and limited locomotive capabilities. By taking advantage of this restriction, the Electronics Unit at the Denver Wildlife Research Center developed a small, crystal-controlled, radio-frequency (RF) oscillator for use as a short-range homing beacon. This beacon differs from typical small-animal transmitters in that it does not contain a tuned antenna structure. An engineering trade-off is therefore made between the strength and range of the radiated signal and the simplicity and weight of the circuit.

## METHODS AND MATERIALS

The circuit diagram and components of the oscillator beacon are shown in Fig. 1. This circuit is a Colpitts or Pierce oscillator with most of the RF leakage radiation provided by the collar attachment (Fig. 2). The collar size is not critical to the oscillation of the circuit, provided that the electrical resistance is not prohibitive. This allows for fast attachment with a minimum of disruption to the animal's normal activity. The circuit oscillation is determined by the frequency crystal; ours is about 30 megahertz (MHz).

The weight of the oscillator circuit with a collar 0.5 inch in diameter and no battery is 0.7 gram. A 40-milliampere hour (mah) mercuric oxide battery increases the total weight to 1.4 grams and gives a predicted transmitter life of 8 days. If a lighter weight is required, a 1.1-gram unit can be constructed with a 16-mah mercuric oxide battery (the predicted life is 3 days). The selection of the power supply for this oscillator is critical. If the maximum battery capacity is to be utilized, a battery with low current drain capability (about 0.2 ma average) must be used. At the same time, the transistor bias current must be adjusted to allow the circuit to operate over the expected ambient temperature range.

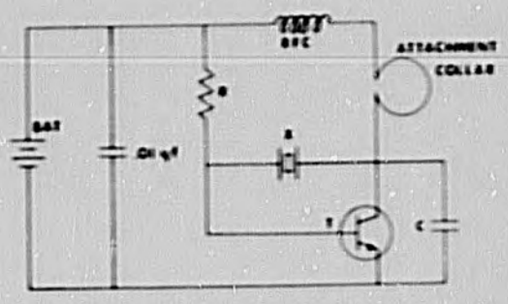


Fig. 1. Crystal-controlled, 30-megahertz radio beacon. Bat = mercury oxide battery; RFC = radio frequency choke (22 turns of AWG No. 38 wound on a ½-watt resistor form); T = NPN transistor (Motorola MMT 23dP); X = frequency control crystal (Erie Technological Products); R = 68 to 180 KΩ resistor (selected for an average current drain of 0.2 ma); and C = 100 to 180 pf capacitor (selected for correct channel frequency).

The detection range of the beacon is determined in part by the sensitivity of the receiving system. The Messenger 350 DF Receiver, manufactured by the E. F. Johnson Company, with a loop antenna 14 inches in diameter, is frequently used at the Denver Center. Reference to trade names does not imply endorsement of commercial products by the federal government. An oscillator with a collar 0.5 inch in diameter was buried 20 inches in the ground and was received within a rectangular area 200 × 90 feet. The beacon was at the geometric center. The same circuit with no collar had a omnidirectional detection range of only 30 feet.

The transmitter was attached to the animal simply by soldering the two collar ends when the unit was fitted snugly around the neck. These collar ends are tinned before being placed on the animal to minimize the soldering time. A piece of heavy paper slipped between the collar and neck insulates against heating discomfort to the animal. Medical hemostats provide a convenient clamp for holding the collar during soldering. Some of our animals were anesthetized with ether during the attachment.

Fig. 2. Pine mouse instrumented with a 1.4-gram, 30-megahertz, radio frequency beacon attached by means of a collar that is 0.5 inch in diameter.

## RESULTS

In a baiting study recently conducted in Bolton, Massachusetts, six pine mice (*Pitymys pinetorum*) and six meadow voles (*Microtus pennsylvanicus*), each weighing from 15 to 25 grams, were instrumented to follow their movements and activities before and after treatment with a toxic bait and to determine the approximate time of any toxicant-induced mortality. We found that the individual animal's body movements were easily detectable from the signal's RF modulation.

Within 48 hours after bait exposure, we observed a complete cessation of all RF signal modulation from the eight mice in the treated area. Since no recovery of the instrumented mice could be attempted

without causing possible root damage to fruit trees, one of three conclusions seemed warranted: the mice were dead, the beacons had separated from the mice, or the mice were dormant for consecutive days. There was no apparent reason, however, to expect the mice to be dormant. When the test was terminated, 7 days after instrumentation, signal modulations from two of four instrumented mice in an adjacent control area were still audible. Of the other two control animals, the signal from one was lost soon after release, probably because of the separation of a cold solder joint. The second animal was monitored for 4 days, and at this time severe RF interference was encountered on its beacon frequency.

These tests indicate that a small, short-range, RF oscillator beacon can provide field biologists with information on animals whose size precludes carrying a 5- to 10-gram transmitter. The 1.4-gram beacon described here was successfully used on rodents weighing 15 and 25 grams, without apparent hindrance to their normal activities.

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