TECHNICAL NOTE

TELEMETRY ON A SHOE-STRING*

1. INTRODUCTION

The cost of transmitting one channel of biological data, for example ECG, seems to range anywhere from $500 to $2500. This price does not in any way relate to distance of transmission and only remotely to quality. After puzzling over this we decided to build our own. It appeared that the best course was to use engineering know-how and technical skills of others in what we think is the most difficult part of any telemetry scheme—a stable transmitting section and receiver. With that philosophy, an investment of $36 was made in a pair of hand held, battery operated, citizen band 27-125 Mc/s “walkie talkies”. The catalogue listed others at $25 and $15 a pair. All of these sets are crystal-controlled, meet the specifications of stability and power set down by our government, and do not require licensing. Crystals can be obtained from the manufacturer for operation in the industrial, scientific, and medical band. The transceivers come with a five foot telescoping whip antenna, use a 37~, 9-V battery, have a range (measured over water) of 189 miles, and weigh 300 g.

2. CIRCUIT DESCRIPTION

With the thought in mind that if this investment proved to be a bad one as far as transmitting ECGs was concerned, that transceivers always come in handy on fishing and hunting trips, we decided to do as little surgery on them as possible. As a result, our receiver is only defaced by a phone plug which allows us to disconnect the speaker. To the transmitter, on the other hand, a differential amplifier and subcarrier oscillator have been added. There are many differential amplifier circuits described in the literature; the one we used is shown in Fig. 1. It has a bandwidth ranging from 0-1 c/s to 200 c/s, a noise referred to the input with a 1 kΩ source resistance of less than 5 μV peak-to-peak, and an input resistance of 250 kΩ. It uses good-quality low-noise silicon transistors priced at $1-50 apiece and has a gain of 500. It was found that the first stage of the amplifier required a.c. decoupling in order to prevent the r.f. from feeding back into the amplifier, being rectified by the base-emitter junction and saturating the amplifier. The amplifier output frequency modulates a subcarrier oscillator; this is necessary in order to prevent detuning effects and signal strength variations from producing artifacts in the transmitted data. The subcarrier oscillator is a simple free running multivibrator, frequency modulated by means of a current source; the characteristics of this circuit have been described in a previous article (Roy and Hart, 1966). The subcarrier frequency chosen was 3000 c/s, mainly because the audio stages already in the transceiver had a bandwidth ranging from 500 to 5000 c/s and also because the modulated tone enables one to listen to the heart rate on the receiver with no additional recording equipment required.

To look at the data transmitted, a demodulator at the receiver is necessary. This is shown in Fig. 2. It consists of a pulse-shaping circuit and a pulse-integrating circuit, as well as a zero-set control and a gain potentiometer. A signal at the input of the transmitter of 1 mV produces an output at the integrator of 50 mV, which is sufficient to be seen on most oscilloscopes, or fed directly into any electrocardiographic pen recorder.

3. PERFORMANCE

The system described performs well. No motion artifact is evident other than electrode or muscle noise. Figure 3 compares a signal which was transmitted, with one recorded directly. Figure 4 shows the transmitter and receiver.

Transmission distances vary and are determined by the surroundings. In an open field, signals have been recorded up to distances of ½ mile. In the laboratory, with the transmitting antenna collapsed, signals have been recorded over distances of 50 to 100 ft. The relative insensitivity of the receiver can be an asset, in that interfering signals are no problem unless someone is on the air in the immediate vicinity. One can, with the added cost of a few components, build a simple band-pass filter and minimize interference by putting the subcarrier frequency out of the audio range—15 to 20 kc/s. There is no reason why more channels cannot be added to the system at, of course, slightly increased cost.

The transmission system as it now stands, including the original cost of the “walkie talkie”, can be made for less than one hundred dollars and can be used both for human and animal studies.

O. Z. Roy

Radio and Electrical Engineering Division
National Research Council
Ottawa, Canada

REFERENCE


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Fig. 1. Amplifier and subcarrier circuit.