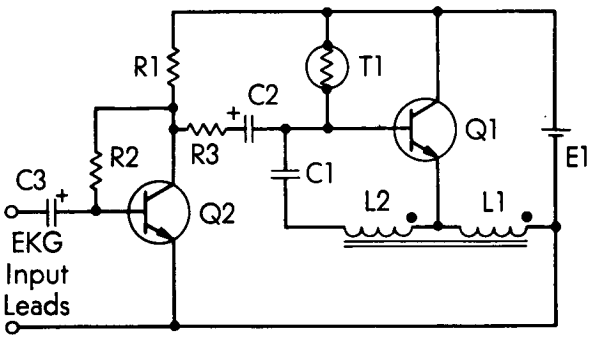
NASA TECH BRIEF

Ames Research Center

Implanted Telemeter for Electrocardiogram and Body Temperature

The problem:

To obtain both electrocardiogram (EKG) and body temperature data from a single transmitter implanted in the body of a small animal without resort to complex switching or multiplexing techniques.



The solution:

A measuring system requiring only one blocking oscillator to generate a modulated pulse repetition rate. A temperature-sensitive resistor in the oscillator circuit determines the average long-term pulse repetition rate of the blocking oscillator and an EKG signal modulates the pulse repetition rate about the average value to provide indication of the EKG input value. The oscillator output is transmitted at radio frequencies to a receiver outside the body where the combined outputs of the two sensors are separated to provide graphs of the functions.

How it's done:

The simple blocking oscillator circuit which is used is comprised of Q1, T1, C1, L1, L2, and E1, as shown in the figure. Blocking occurs in this circuit because, during oscillation, the sinusoidal voltage appearing across L2 is rectified by the base-emitter junction of Q1, resulting in a negative voltage build-up on the base (of Q1) side of C1. This negative voltage cuts Q1 off sharply and holds it off until enough current can flow through T1 (or, through C2 also) to reverse the charge on C1. The length of time between bursts of oscillation will thus depend directly upon the actual resistance of the thermistor T1 which, in turn, varies as a function of temperature.

The remaining components comprise an amplifier designed to boost the EKG signal (approx. 1mV peak-to-peak) to about 20 mV. This signal is then coupled to the transmitter section through R3 and C2. Since the EKG waveform varies rapidly in comparison with the average pulse repetition frequency (PRF) of the transmitter, it is able to increase or decrease the PRF fairly rapidly about the mean rate which is established by the body temperature (in animals, temperature changes occur slowly; hence, over short intervals of time, the mean PRF is constant and variations are assessable to EKG potentials). Of course, neither form of modulation affects the "carrier" frequency, i.e., the resonant frequency of the antenna coil (L1-L2).

Using design values for the circuit components, the transmitted data may be received at a number of points on any standard AM radio dial. This wide spectrum is due to the fact that the output is pulsed rather than purely sinusoidal and is thus rich in harmonics. The output of the AM receiver may be fed into a frequency-to-voltage converter which, in turn, may be used to drive a chart recorder. If the converter is AC coupled into the recorder, only the rapid variations of the EKG signal will be seen. If the signal is also fed into another channel on the recorder, one that is DC coupled, and if it is filtered to eliminate the relatively high frequencies of the EKG waveform, the level of this DC voltage will be proportional to temperature.

(continued overleaf)

The transmitter and battery may be enclosed within two flat-bottomed, cylindrical, glass containers (such as bottle halves) which are cemented together with a highly moisture-resistant epoxy to provide a rigid and watertight container; the thermistor should be cemented to the inner surface of the glass to improve the speed of response of the temperature circuit. A medical grade silicone encapsulant may be smoothed over the epoxy junction between the two glass halves to prevent any tissue reaction from occurring once the telemeter is implanted inside an animal. The radiating antenna should be located as far away as possible from the metal-encased battery to minimize loading of the transmitted signal.

Notes:

1. The device as constructed has an expected useful life of about two years; useful transmission range is about three feet.
2. The EKG sensing unit may also be used to sense the electromyogram or the electrooculogram of laboratory animals.
3. The basic principle of operation of the telemeter's circuit may be employed whenever it is desired to monitor a resistance and/or a voltage change, taking advantage of the isolation afforded by the RF link.
4. Requests for additional information may be obtained from:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP72-10035

Patent status:

This is the invention of a NASA employee, and U.S. Patent No. 3,534,728 has been issued to him. Inquiries about obtaining license rights for its commercial development should be addressed to the inventor, Mr. William F. Barrows, at Ames Research Center.

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(XAC-08505)