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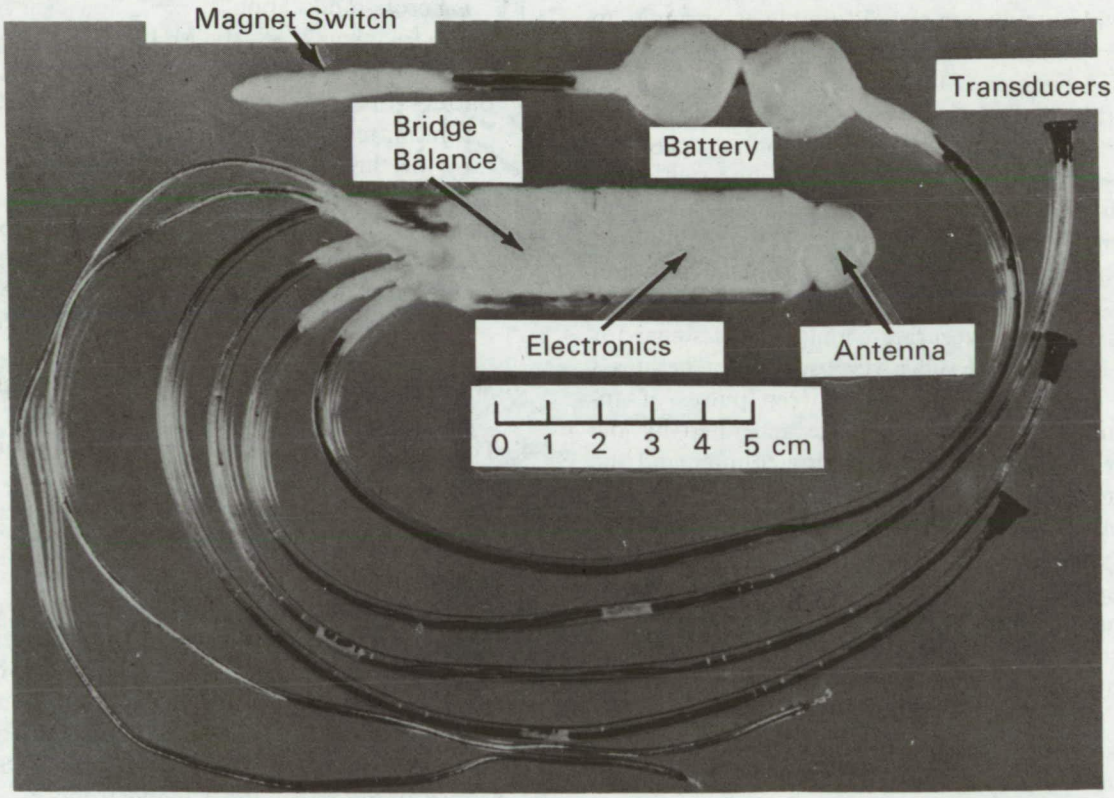
NASA TECH BRIEF

Multichannel Implantable Telemetry System



The problem:

To develop a multichannel telemetry system suitable for chronic implantation in animals to monitor a variety of physiological parameters. It is desirable to design the system such that the number of channels can easily be increased or decreased depending upon the requirements of the experimenter.

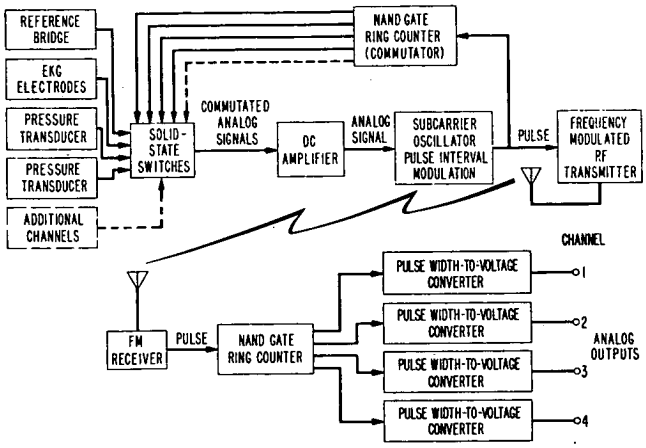
The solution:

A hermetically sealed unit using a time-sharing multiplex scheme to commutate between various sensor inputs. To date experiments requiring multiple pressure sensors, EKG, and temperature have been accommodated. Units having 5 and 8 channels have been built and tested. The essential features of small size and low power required for implantable physiological telemetry have been achieved without sacrificing accuracy and reliability.

How it's done:

The telemetry system is shown as a block diagram. The upper section of the figure shows the implanted

(continued overleaf)



transmitter part of the system. The lower part of the figure is the receiving and demodulating equipment that provides an analog signal suitable as an input to a pen recorder.

The ring counter is the key element in the operation of this multichannel transmitter. A *nand* gate ring counter is used as a commutator to operate a series of solid-state switches. There is one switch for each input channel and these are operated in a sequential manner by the commutator. The commutated signal is amplified slightly and then applied to a subcarrier oscillator. The subcarrier oscillator is used in the system to allow accurate coding of the signal for RF transmission. The subcarrier oscillator generates a series of pulses with a period between pulses of approximately 0.7 msec. Each pulse generated by the oscillator is used to advance the ring counter and the solid-state switch one position to sample the next analog input. The oscillator pulses are also used to frequency modulate an RF oscillator. The RF signal is then radiated by means of an antenna to the receiving system.

Each sensor is connected to the transmitter by lead wires contained in medical grade tygon tubing. Another tygon-covered lead connects to the battery and a magnetic latching switch, which are usually placed just under the skin of the animal, to facilitate operation of the switch and renewal of battery. With this arrangement, long-term (1–2 year) telemetry experiments are possible.

Notes:

1. One of the multiple channels is used for reference and calibration purposes to obtain long-term system accuracy and stability.
2. The basic operation, except for the addition of a multichannel capability by means of a commutating switch, is similar to that of single-channel circuits that have been described in NASA Tech Briefs 64-10171, 66-10057, and 66-10624. These Tech Briefs are available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $0.15 each.
3. The following is a summary of the major system performance characteristics:
   Number of channels—Systems with five and eight channels have been tested, but the system can easily be adapted to more or less channels.
   Sample rate—Approximately 0.7 msec per channel.
   Frequency response—DC to 50 Hz.
   Transient response—5 to 7 msec for five-channel system.
   Input impedance—Suitable for 5K strain-gage bridges, or approximately 150K when used with biopotentials such as EKG.
   Noise level—Less than 20μV peak to peak, including cross-modulation
   Radio frequency—88–108 MHz.
   Power supply—2.7 V(2 mercury cells).
   Battery drain—Approximately 2.5 ma for the transmitter system. (The total current required by the three pressure cells and reference bridge used in this instance is 1 ma.)
   Operating life—200 hours continuous operation using a 500 ma-hr battery.
   Size—Transmitter (independent of battery and transducers) approximately 1 cm by 2 cm by 8 cm.
   Weight—Transmitter, 70 gm. (Two 500-ma-hr mercury cells (pacemaker type); 16gm.)
4. The size and weight could be reduced further by using integrated circuitry.
5. An encapsulated transmitter has been implanted in a dog and heart measurements have been successfully telemetered to a distance of 200 feet.
6. Additional details are contained in a paper, *A Multichannel Implantable Telemetry System,* by Thomas B. Fryer, Harold Sandler, and Boris Datnow, which was presented at the 7th International Conference on Medical and Biological Engineering, August 15–19, 1967, Stockholm, Sweden. Copies of this paper are available from:
   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B68-10065

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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(ARC-10083)