An Accelerometer Module for Transmitter Applications

Fourth in a series on the Foxmitter and accessories for a variety of inputs...

by Richard Q. Fox

The instrumentation of model rockets with accelerometers is basic to research in model rocketry, but not much development has been done in this area. The accelerometer described is different from all other inexpensive accelerometers currently available because this accelerometer produces a continuous record of the acceleration of the rocket, and not just an indication of the maximum acceleration. The accelerometer data transmitted from the rocket can be used to determine not only the acceleration of the rocket, but also the velocity and the distance traveled, at each instant of flight.

The cost of the parts necessary to build the accelerometer module is about $3.00. The accelerometer-transmitter combination is about 9 inches long, and weighs 2.5 ounces. It is designed to work in conjunction with the transmitter described in the May 1969 issue of Model Rocketry.

Construction

A slight modification to the transmitter is necessary to use the accelerometer module. One leg of capacitor C2 must be disconnected from the negative bus and

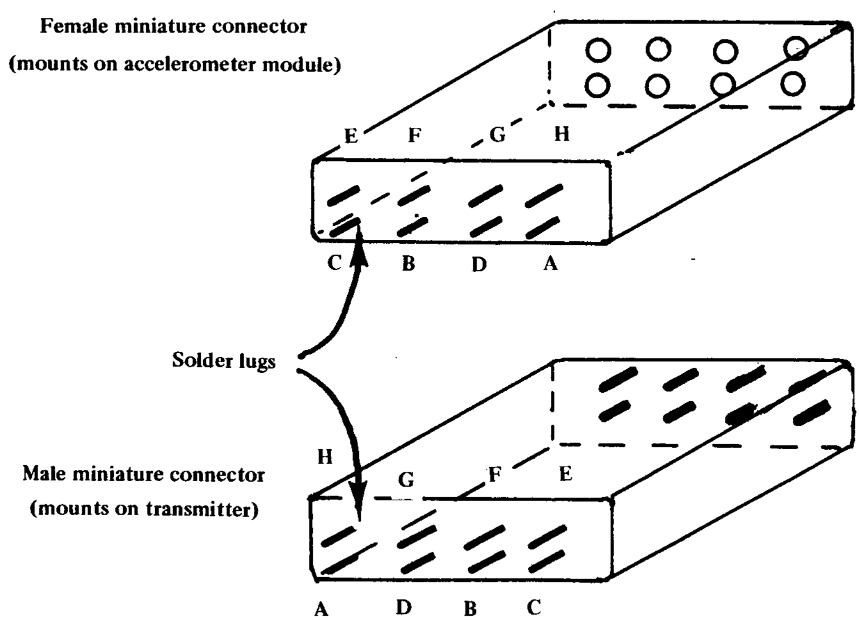


Figure 1

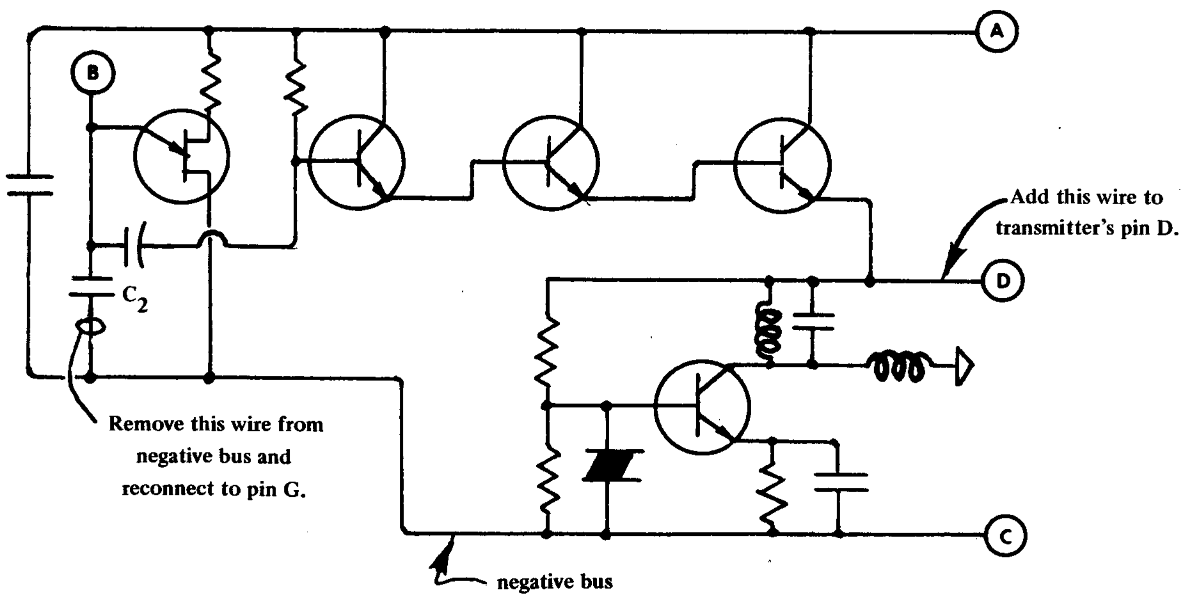


Figure 2
Modifications to Basic Transmitter

connected to pin G on the black plug as shown in Figure 2. In addition, a wire must be run from the emitter of Q4 to pin D on the black plug. The beacon tone module, the temperature sensing module, and the spin rate sensing module must be changed as shown in Figure 3 in order to remain compatible with the transmitter. These simple changes make the transmitter more versatile. Future modules will be designed with these changes in mind.

Construction of the accelerometer module itself is very simple. Mount the parts as shown in Figure 5 and keep all wires as short as possible. Do not make any substitutions in part values.

The acceleration sensitive inductor is constructed by using the Miller no. 9003 coil, a small washer, and a spring as shown in Figure 4. Remove the sheet metal nut from the end of the coil and discard it. Glue a small washer against the other end of the coil. Next, obtain a spring with a diameter of ¼ inch and a length of 1¼ inches. The spring should compress to a length of ¼ inch under 1 ounce of force. The most likely place to obtain such a spring is in a spring assortment package at a hardware store. The spring should be placed inside the coil, and the slug should be placed on top of the spring. With this arrangement, the slug will slide further into the coil when the coil is acted on by an accelerating force.

Flight Preparation

The accelerometer-transmitter should be flown in the vehicle described in a separate article next month. While the rocket is transmitting in flight, the signal should be received on the ground and tape recorded. The tape recorded signal can then be used to calculate the acceleration, velocity, and distance traveled in the flight.

Data Reduction

The signal sent from the accelerometer is a tone whose frequency is proportional to the acceleration of the rocket. Use the calibrator described in the June issue of **Model Rocketry** to convert the tape recording of the tones generated during the flight into a table of relative tone values versus time. This is done by matching the tones of the flight recording with tones generated by the calibrator described in the June issue. The settings of the calibrator necessary to match each tone of the flight recording are recorded on paper as the "relative values" of acceleration. The conversion of relative values to actual acceleration values is accomplished through the use of a conversion factor.

The conversion factor is determined as follows: Weigh the accelerometer coil slug on a sensitive balance. Then weigh a convenient large nail. Place the slug back in the accelerometer coil and turn the transmitter on. Be sure to position the transmitter so

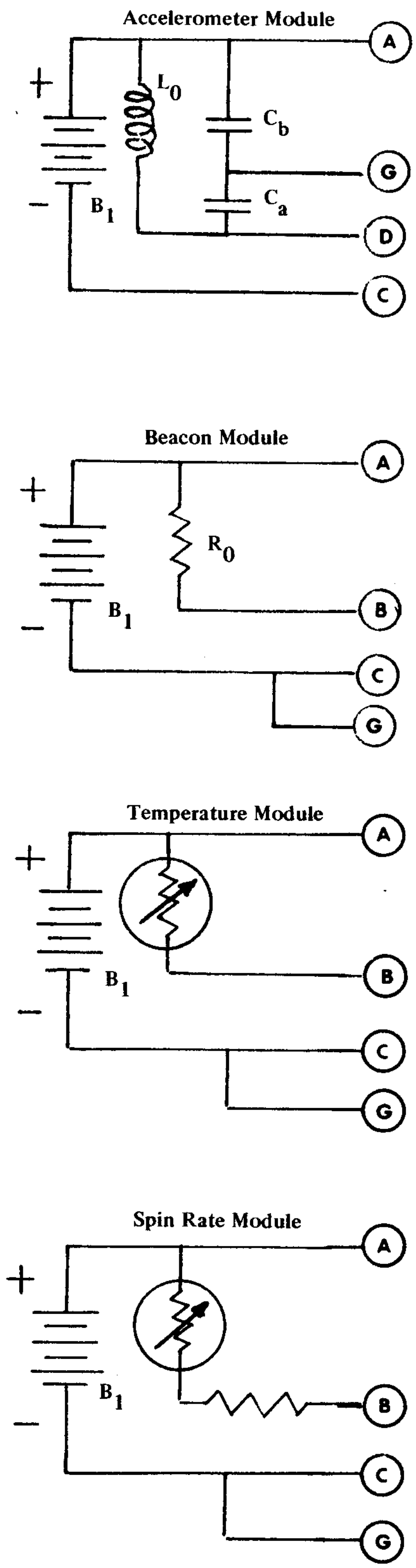
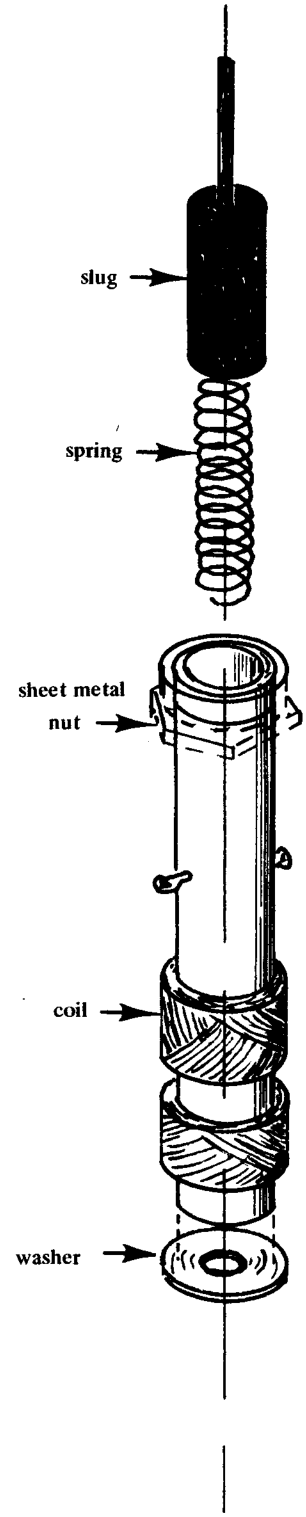


Figure 3



Inductor Assembly

Glue washer to bottom of coil, to keep spring from coming out bottom.

Figure 4

that gravity pulls the slug against the spring. Match the tone generated by the accelerometer with the calibrator tone and record the value. The matching tone that the calibrator generates has the relative value of one "g" of force. Now carefully place the nail on top of the threaded portion of the slug. The weight of the nail will simulate an acceleration force by pushing the slug further into the coil. This simulated value of acceleration can be calculated by dividing the weight of the nail by the weight of the slug, and adding one to the answer. $F_a = W_n/W_s + 1$ where F_a is the acceleration force being simulated, W_n is the weight of the nail, and W_s is the weight of the slug. With the nail on the slug, match the calibrator tone to the accelerometer tone and record the value. This simulation of acceleration force provides a second piece of information to help relate the relative values of the calibrator tones to the actual "g's" in flight. Additional data points are needed, and they can be obtained by placing other objects of known weight on top of the accelerometer coil slug and matching the tones produced with the calibrator. Once enough data has been obtained, the results can be plotted and saved as a permanent calibration of the accelerometer.

The calibration graph is then used to convert the relative values from any flight into a table of acceleration versus time. A plot of the acceleration versus time data should look similar to the thrust versus time curves shown in the manufacturers' catalogues.

The conversion of the acceleration data to velocity and distance data is done by integration. There are a number of methods of integrating the data, including the use of analogs and mathematical approximations, but they will not be presented at this time. Some model rocket manufacturers offer technical reports on the subject, and **Model Rocketry** magazine will cover the subject in a future issue.

Next month **Model Rocketry** *will carry the fifth in a series of articles on model rocket transmitters, dealing with a special payload carrier for the transmitter and its various sensors.*

For information on the basic transmitter circuit and other sensors refer to these back issues of **Model Rocketry***:*

May 1969 – *Building an Inexpensive Model Rocket Transmitter*

June 1969 – *A Temperature Sensor*

July 1969 – *Build a Spin Rate Sensor and Direction Finder*

All of the instrumentation described in this series is compatible with the May 1969 transmitter design.

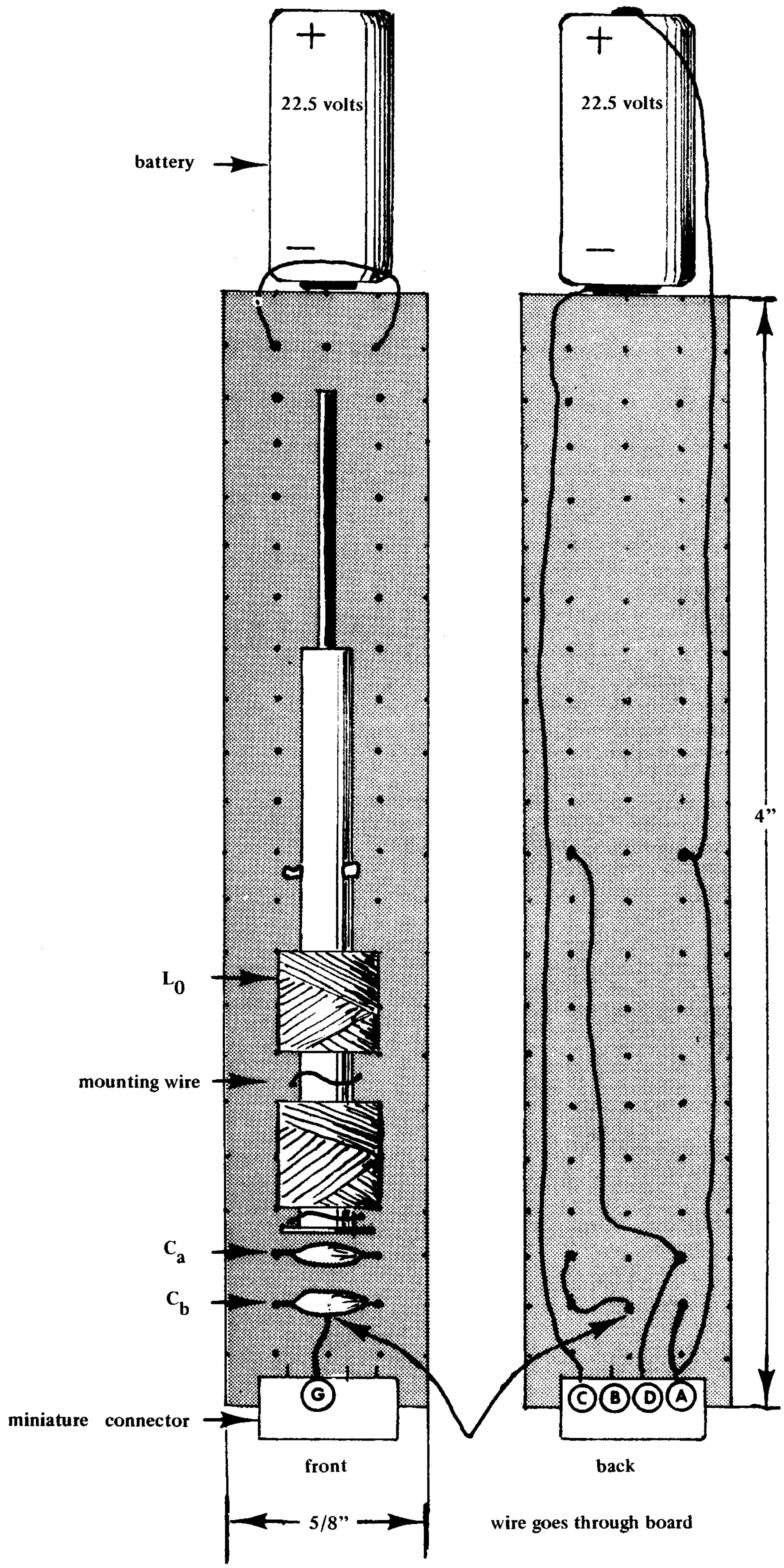


Figure 5 Wiring Diagram