

# NASA TECH BRIEF

## NASA Pasadena Office

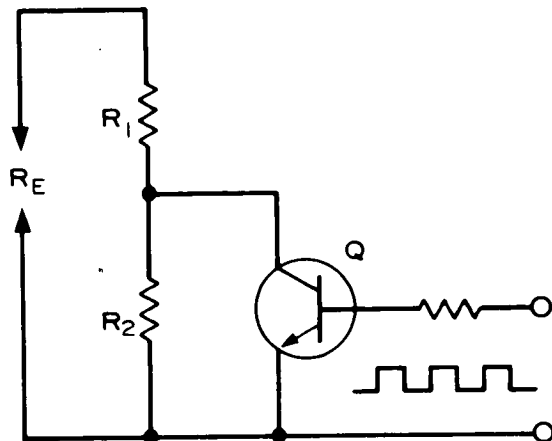


NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

### Time-Adjusted Variable Resistor

#### The problem:

To vary the effective value of a fixed resistor and obtain a desired resistance with extreme precision.



#### The solution:

All or a portion of the fixed resistor is shunted by a switch; the effective resistance of the assembly over an interval of time can be varied by adjusting the rate of closure of the switch.

#### How it's done:

The elements of the time-adjusted variable resistor are indicated in the diagram where  $R_1$  and  $R_2$  represent two resistors and  $Q_1$  is an electronic switch. In principle,  $Q_1$  could be a mechanical switch operated at low frequencies, but it is more convenient to use a transistor because it can be operated for long periods of time at very high frequencies with no contact noise. If the length of time the switch is open is designated

as  $T_o$ , and the length of time the switch is closed is  $T_c$ , then the duty cycle of the switch is  $1/(T_o + T_c)$ . For the simple case where  $R_1$  is zero, the resistance of the open switch is infinity, and the resistance of the closed switch is zero, the effective resistance,  $R_E$ , of the combination obviously is  $R_E = R_2 (T_o / (T_o + T_c))$ . The effective resistance can be raised essentially from zero to  $R_2$  by varying the duty cycle. When  $R_1$  is not zero, the effective resistance can be varied from  $R_1$  to  $(R_1 + R_2)$ , and by utilizing other combinations of resistors and switches, a wide variety of effective resistances can be obtained. Of course, the transistor must be driven hard on and then full off, and the "on" resistance should be a very small fraction of  $R_2$  while the "off" resistance should be very large.

At present, extremely precise fixed resistors and timing mechanisms are available at reasonable cost; in contrast, variable resistors capable of being set to a desired value with high precision are relatively expensive. Thus, a time-adjusted variable resistor of the type described above can be used economically in any circuit which is insensitive to the rate of switching; a typical example is a DC Wheatstone bridge which uses a highly damped galvanometer as a detector.

#### Notes:

1. A practical use of the time-adjusted variable resistor is indicated in Tech Brief B72-10507.
2. Requests for further information may be directed to:

Technology Utilization Officer  
 NASA Pasadena Office  
 4800 Oak Grove Drive  
 Pasadena, California 91103  
 Reference: TSP72-10116

(continued overleaf)

**Patent status:**

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel  
Mail Code 1  
NASA Pasadena Office  
4800 Oak Grove Drive  
Pasadena, California 91103

Source Richard C. Heyser of  
Caltech/JPL  
under contract to  
NASA Pasadena Office  
(NPO-11306)