NASA TECH BRIEF

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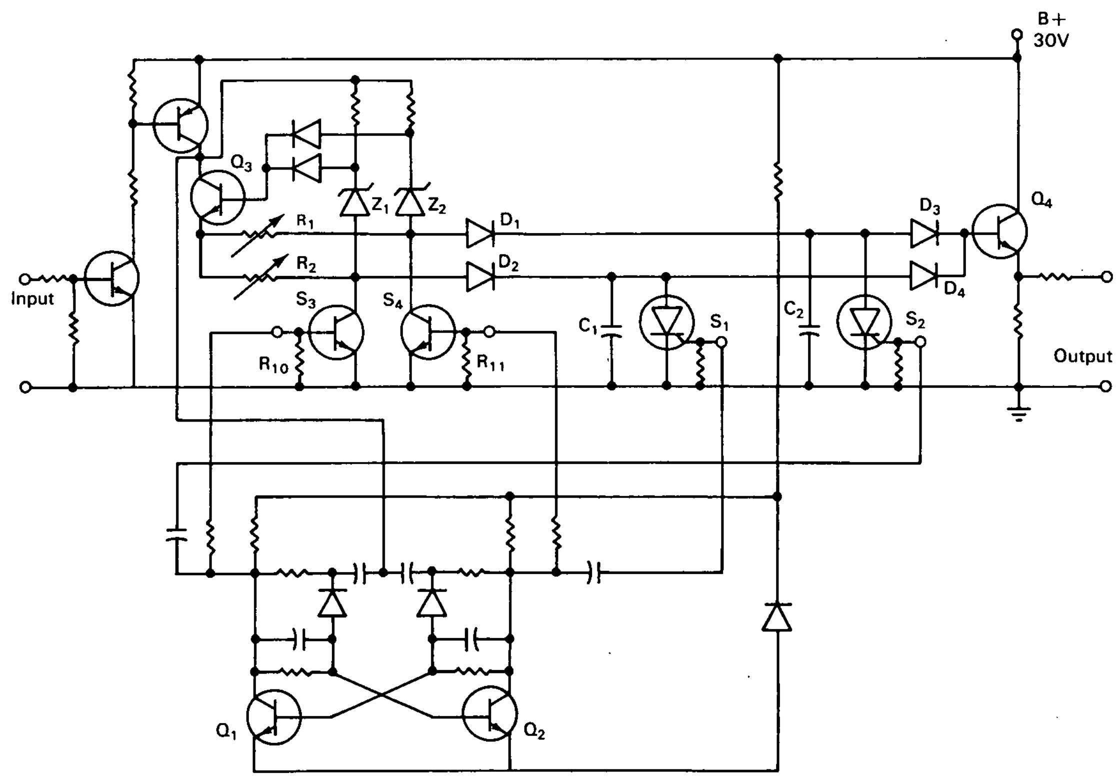
Solid-State Switching Used to Speed Up Capacitive Integrator



The problem: Where the width of variable electric pulses is of interest, as in a control system that indicates certain parameter changes by changes in pulse width, a method of converting the pulses to an analog voltage is needed in order to measure such pulse width. Conventional capacitive integrators that perform this conversion use relays for switching the capacitors. Relays have limited operating lifetime, draw appreciable power, and cannot be switched in much less than two milliseconds.

The solution: A capacitive integrator that uses silicon controlled switches (SCS's) to steer each input pulse to the proper capacitor (C_1 or C_2) in a sequence of charge, discharge, and read. The circuit has a response time in microseconds.

How it's done: The silicon transistors S_1 and S_2 are alternately biased on by the bistable multivibrator formed by Q_1 and Q_2, which is triggered by the trailing edge of each input pulse. At the end of each pulse,

(continued overleaf)

the capacitor that is next to be charged is unloaded of its previous charge by a shunted silicon controlled switch (S_3 or S_4) that is also triggered by the multivibrator. Blocking diodes D_1 and D_2 prevent discharge of the capacitors (C_1 and C_2) through the charge components. Capacitors C_1 and C_2 are charged by the constant current circuit Q_3, Z_1, Z_2, R_1, and R_2. This circuit insures an output voltage that is linearly proportional to the input pulse width. Maximum linear output voltage level is determined by the zener voltage of Z_1 and Z_2 and the magnitude of the input pulse since: $V_{out} = V_{in} - V_{out} = V_{B+} - 2V_Z$. Capacitors C_1 and C_2 are connected to the base of the combined emitter follower Q_4 through D_3 and D_4. This circuit exhibits an output equal in magnitude to the highest voltage appearing on either C_1 or C_2. It also provides a high input impedance (500K ohms) to prevent transient discharge of the capacitors, while maintaining a relatively low output impedance.

System output can be considered as an integral function of the input on a single pulse basis, or as an RMS (root mean square) equivalent of a series of evenly spaced pulses.

Notes:

1. A modified version of this circuit has been used successfully for over eight months to integrate the output of an infrared horizon scanner for space exploration.
2. The circuit can be used to integrate either high or low duty cycle pulses with repetition rates ranging from 1 pulse per second to over 10,000 pulses per second with negligible ripple factors.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Langley Research Center
   Langley Station
   Hampton, Virginia, 23365
   Reference: B65-10159

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

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