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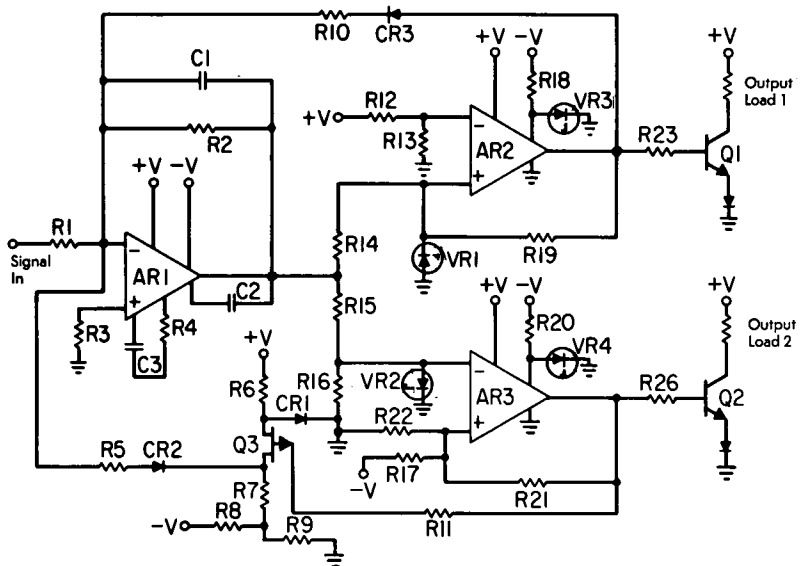
NASA TECH BRIEF

Ames Research Center

Pulse Width-Pulse Rate Modulator



The problem:

To control the duty cycle of the pneumatic valves associated with the attitude control system of rockets so that less fuel is required.

The solution:

A pulse width-pulse rate attitude control system wherein the operation time of each valve is directly proportional to the error signal and the dead band about a null can be controlled by independently adjustable threshold circuits.

How it's done:

The pulse width-pulse rate circuit which is the heart of the control system consists of an integrator and threshold switches to turn a pair of solenoid valves completely on or completely off. The integrator amplifier AR1 is a high-gain integrated circuit operational amplifier with two negative feedback loops that convert it to a pulse width-pulse rate modulator. The output of this amplifier drives two threshold switches, each consisting of identical integrated circuit differential comparators with an hysteresis that is a function of positive feedback; when the input exceeds a predetermined level, the output switches.

When an input signal is applied to the circuit, the signal is integrated by AR1 to a predetermined threshold level. The inverted output of the integrator is a positive- or negative-going ramp which rises or falls at a rate that is directly proportional to the input signal, either positive or negative.

A positive and a negative reference voltage is applied to threshold switches AR2 and AR3, respectively. With a positive input signal applied, threshold circuit AR3 switches when the output of the

(continued overleaf)

integrator reaches the AR3 threshold. The output of AR3 turns off transistor Q3 which causes a voltage of opposite phase to appear at the input summing junction. This causes the integrator output to reverse direction. The output pulse stays on until the integrator output goes below the threshold trigger point. Because of threshold hysteresis, the output pulse can be made to stay ON for some predetermined length of time. Operation of threshold switch AR2 is identical to AR3 except that inversion of the AR2 output is not necessary.

Diodes CR2 and CR3 are reverse-biased under no-signal conditions, preventing the voltage at the output of AR2 and Q3 from appearing at the summing junction, which produces minimum integrator offset. Zener diodes VR1 and VR2 limit the minimum signal that can be applied to AR2 and AR3. A small positive potential is developed at Q3 source by CR1 and R6.

Note:

Requests for additional information may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
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Patent status:

No patent action is contemplated by NASA.

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