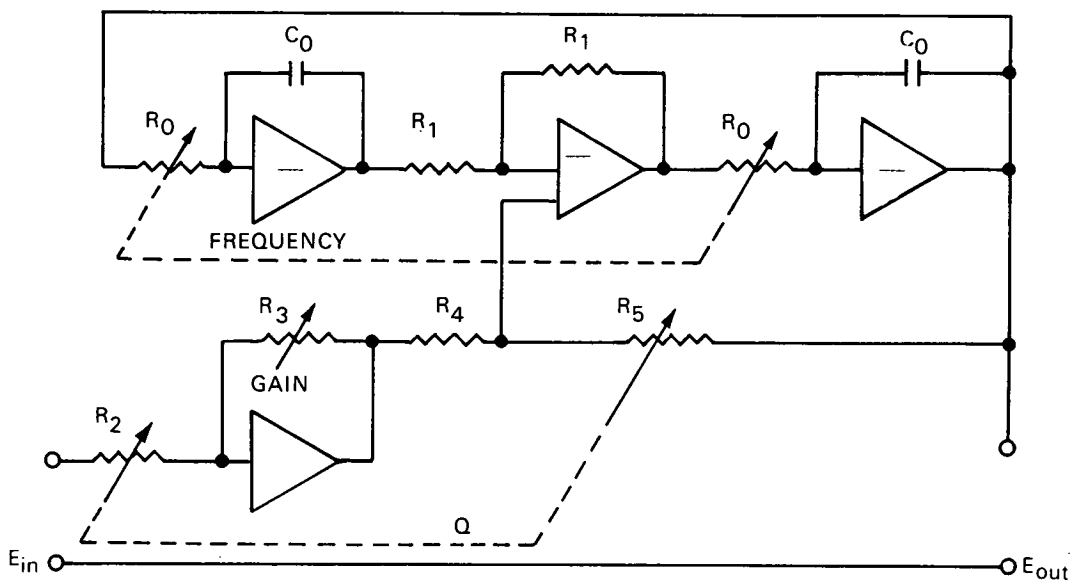
May 1969

Brief 69-10130

NASA TECH BRIEF

Tunable Bandpass Filter with Variable Selectivity



The problem:

Design a stable, active RC bandpass filter having continuously variable, noninteracting control of center frequency, Q, and center frequency gain suitable for operation at high Q.

The solution:

Basic active RC networks constructed from stages that realize second-order transfer functions using two integrators offer excellent stability. Due to the ready availability of integrated circuits, this method is selected as the most practical for construction of a tunable filter for laboratory use. Modifications of the basic network, as shown in the figure, produce a highly stable bandpass filter having separate controls that independently adjust center frequency, Q, and center frequency gain.

How it's done:

The basic circuit is not suited to such general purpose use because the various passive components which can readily be varied do not provide independent control of tuning, Q, and gain. (In an earlier Tech Brief, Q could be adjusted without affecting the center frequency, but not vice-versa and both controls changed the center frequency gain.)

The complete transfer function of the circuit shown is:

$$\frac{E_{out}}{E_{in}} = \frac{\dfrac{2R_3R_5}{R_2(R_4+R_5)}\,(pR_oC_o)}{(pR_oC_o)^2 + \dfrac{2R_4}{R_4+R_5}(pR_oC_o) + 1}$$

(continued overleaf)

The center frequency in Hertz is given by $f_o = \frac{1}{2\pi R_o C_o}$ and is controlled by the ganged variable resistors, R_o. The selectivity is controlled by R_5 since $Q = 1/2 + (\frac{1}{2R_4})R_5$, ($R_4$ is fixed). The gain at center frequency is given by $G_o = \frac{R_5 R_3}{R_2 R_4}$ = (constant) R_3 because the ratio R_5/R_2 is kept constant by ganging R_5 and R_2. Note that the Q and gain controls are also linear. This technique is particularly useful in processing low-frequency bioelectric signals wherein the center frequency of interest may vary with time or with the subject.

Notes:

1. The basic circuit is described in NASA Tech Brief 68-10210, June 1968.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10130

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D. C. 20546.

Source: William J. Kerwin and Charles V. Shaffer
Ames Research Center
(ARC-10191