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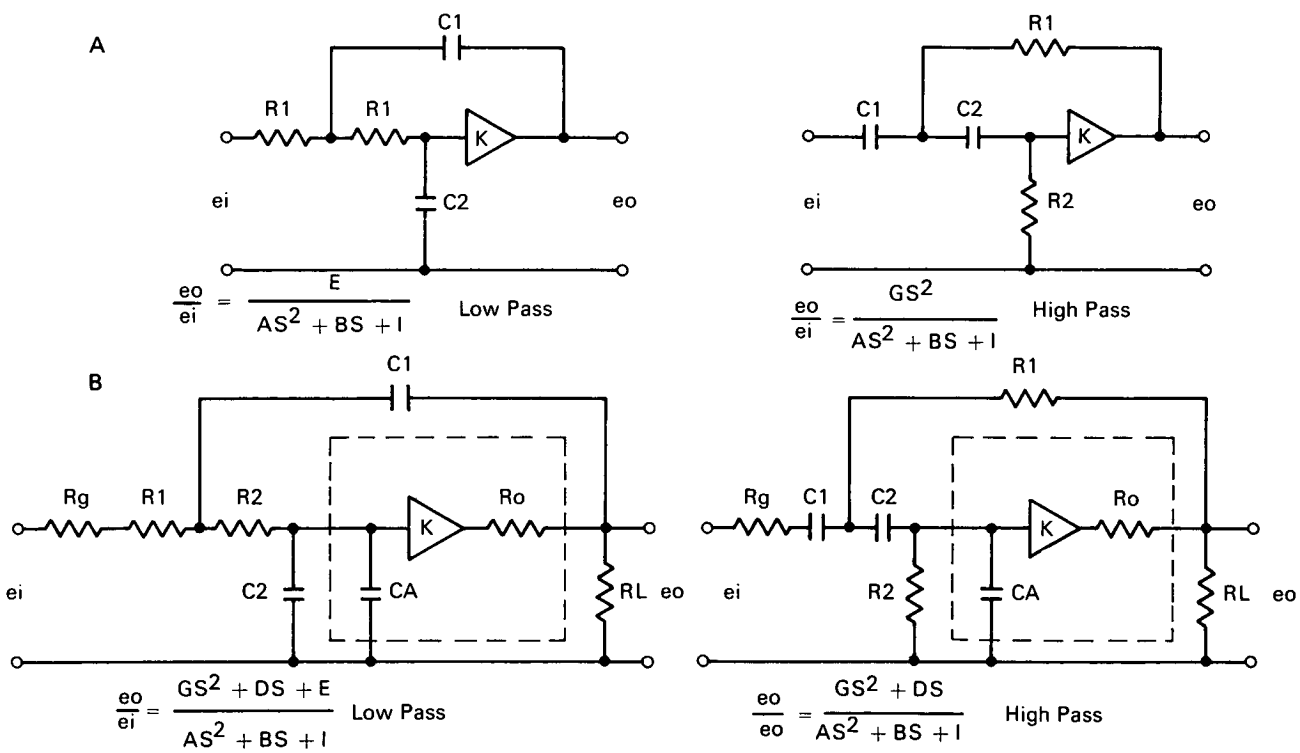
NASA TECH BRIEF

Design Procedure for Improved Active Filters



Active Quadratic Filter Networks: Conventional (A) and Realistic (B)

The problem:

To design an active filter with accuracy for high frequencies. Active filters of conventional design are accurate for only low frequencies usually below 1 kHz, and thus are seldom used.

The solution:

A new synthesis technique for active filters gives a high degree of accuracy for frequencies as high as 500 kHz, so that most frequencies used for telemetry are covered; a frequency response can be realized within a few percent of specified cutoff frequencies without need for tuning.

How it's done:

Basically the technique consists in taking ideal active networks used in conventional low-frequency design (Figure A) and extending their analysis to in-

(continued overleaf)

clude effects of higher frequencies. The reason for the inaccuracy at higher frequencies is that conventional models do not provide for all the parameters that affect the network at such frequencies; they assume zero source and infinite load impedance, and an ideal unity-gain amplifier element having infinite input impedance and zero output impedance.

For accurate synthesis for higher frequencies, additional circuit parameters must be considered for development of an accurate realistic model. They proved to be the amplifier's input capacitance (CA), output resistance (Ro), and gain (K); the source impedance of the input generator (Rg), and output load (R1) (Figure B). These parameters add more terms to the numerator of the voltage-transfer functions and alter the coefficients of the existing terms. By taking these additional parameters into consideration one can realize the frequency response of the filter with much greater accuracy.

The new synthesis procedure for design was based on these more realistic network models. Equations (*1*) describing the networks were derived for calculation of the values of components required for realization of the networks for a given response. Many tests have shown the design techniques to be highly accurate.

The equations describing the higher-frequency models are much more complex than for the ideal lower-frequency models and require laborious calculations. Therefore computer programs were developed (*2*) for performance of all computations required for the analysis and for synthesis of the active filters. With the programs one calculates the component-network values required for realization of the networks, along with the filter's response characteristics including amplitude, phase, time delay, and group delay responses. The programs are written for easy use by designers inexperienced in design of active filters.

The new procedure can be used for design of special filters in low-pass, high-pass, or band-pass configuration for frequencies up to 500 kHz. The techniques are especially applicable for telemetry or communications when accuracy in design is important.

References:

1. S. Gussow and G. Weathers. *Rept. SP-206-0080* (Sperry Rand Corp., Huntsville, Ala., 1968).
2. S. Gussow, "Analysis and synthesis of active quadratic filter networks for telemetry applications," thesis, Univ. of Alabama, Huntsville, 1968.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: TSP70-10238

Patent status:

No patent action is contemplated by NASA.

Source: S. Gussow and G. Weathers of
Sperry Rand Corp.
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