



State Variable Filter Utilising TRAC

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The TRAC family of Totally Reconfigurable Field Programmable Analog Devices offer an integrated path from signal processing problems to working silicon solutions - in minutes!

Introducing a Top-Down, Structured design discipline, TRAC enables rapid implementation, prototyping and product release. Rather than designing at the component level, TRAC champions a Computational Approach. Using eight simple mathematical building-blocks, any transfer function or mathematical equation can be implemented on TRAC, and more besides!

With a combination of programmable silicon and design software, TRAC brings a truly Integrated Route to signal processing problem solving, providing designers with benefits formerly associated only with programmable digital devices, and offering a path to Custom Silicon for higher volume users.

Introduction

Filters are frequently used in many sections of electronics, such as instrumentation and communication industries. Filter design have evolved over the years from being incredibly difficult and only designed by

specialists to a directory of tried and tested circuits.

Very often filters with flat bandpass and steep roll off (high Q) are required. These type of filters are required to cut out all frequencies outside the specified range.

Active filters can be configured as Low-Pass, High-Pass, Band-Pass, and Band-Reject filters.

In this application note a State Variable Filter is realised utilising TRAC.

Theory of Application

A lot of ingenuity has been dedicated in inventing clever active filters, each of which may be used for generating a specific transfer function such as the Butterworth, Bessel, Chebyshev, etc.

These standard filters provide many different compromises between ideal and achievable values of the various parameters.

Some of the major features to consider in selecting an active filter characteristics are;

- (a) small number of parts, both active and passive, (b) ease of adjustability, (c)

small spread of part values, (d) good undemanding use of the OP-AMP, specifically, with reference to slew rate, bandwidth, and output impedance, (e) ability to make high Q filters, and (f) sensitivity of filter characteristic to component values.

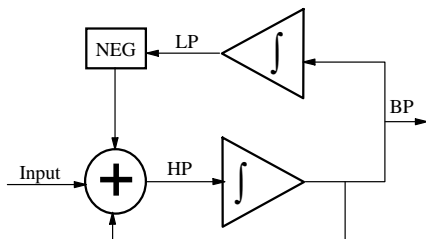


Figure 1
State Variable Filter Block Diagram

The 2-pole state variable active filter is shown in Figure 1. This type of filter is quite popular because of its improved stability and ease of adjustment. One of the major advantages of this filter is the availability of low-pass (LP), high-pass (HP) and band-pass (BP) outputs as

shown above. Another attractive property of this circuit is that its frequency can be tuned while maintaining constant Q in the bandpass characteristic.

As with other type of active filters, multiple stages can be cascaded to generate higher order filters.

Software

Adopting the “computational approach”, TRAC can be utilised to implement a state variable filter in a single device and incorporating minimum number of external components.

This design consists of two identical integrators, adders, and an amplifier for gain adjustment (if required).

The value of the resistors and capacitors set the centre frequency of the filter F_c . The centre frequency is simply calculated by the standard equation;

$$f_c = 1/2\pi RC$$

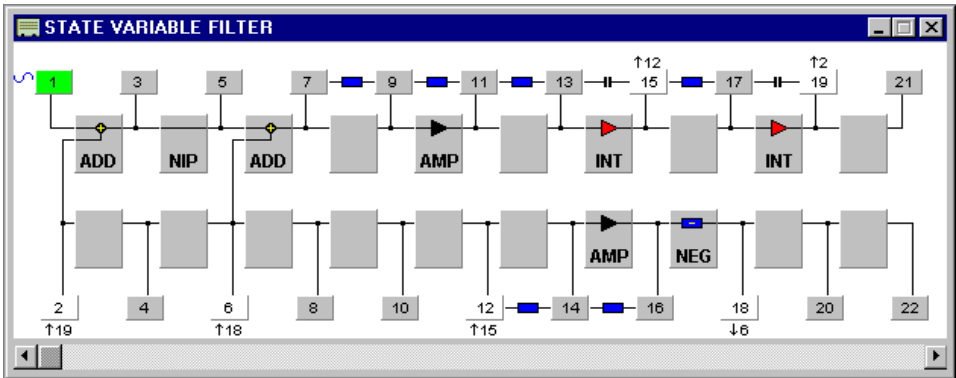


Figure 2
State Variable Filter utilising TRAC.

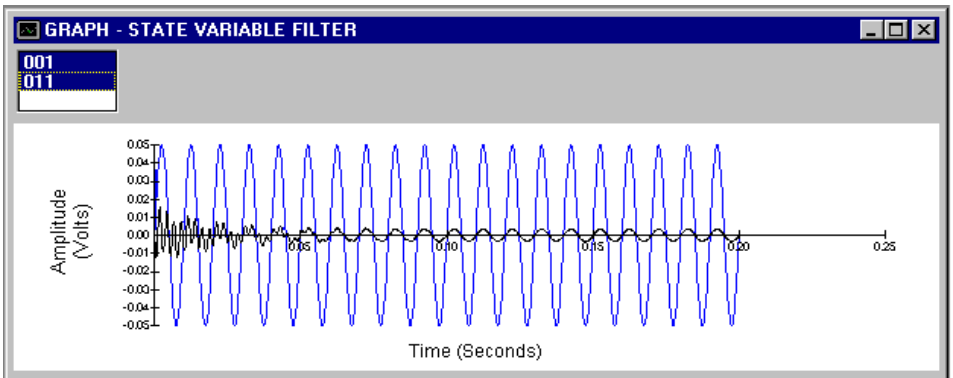


Figure 3
Simulation result for the State Variable Filter's High-Pass response

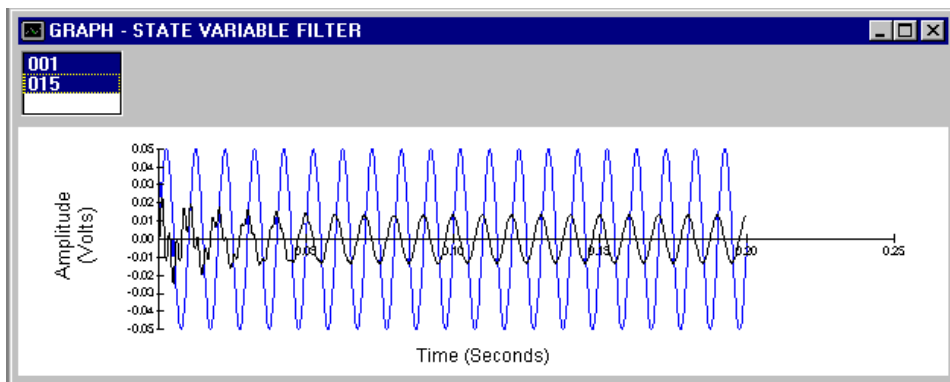


Figure 4
Simulation result for the Band-Pass response

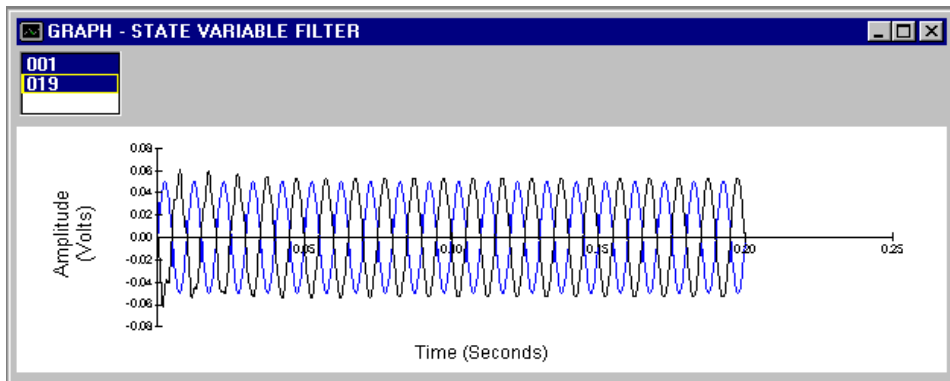


Figure 5
The simulation result for the Low-Pass response

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