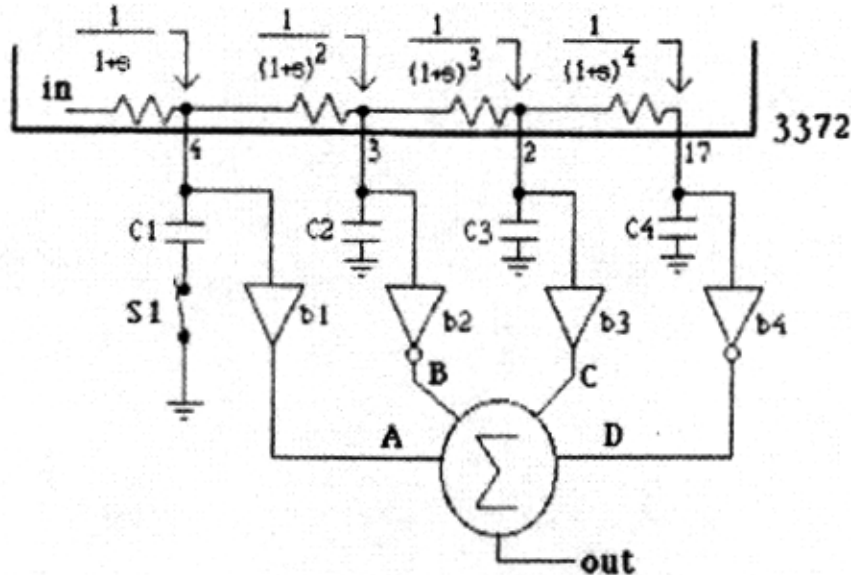


## OBERHEIM MATRIX 12 AND EXPANDER MULTI - MODE FILTER: DESCRIPTION

Although the VCF implemented in the CEM3372 is a standard 4~pole low pass filter, the additional circuitry made of UX14, UX13, UX15, UX17, and the one percent resistor array on the left of UX17 allows 15 different filter modes including high pass, band pass, notch and all pass. Understanding how this magic trick happens requires a little theory.

The figure below shows a simplified representation of the circuitry.



The *complex* representation of the transfer function of a 1-pole low pass filter is:

$$\frac{1}{1+s}$$

Therefore, the transfer function of the network will be:

$$\begin{aligned} \frac{\text{out}}{\text{in}} &= \frac{A}{1+s} - \frac{B}{(1+s)^2} + \frac{C}{(1+s)^3} - \frac{D}{(1+s)^4} \\ &= \frac{As^3 + (3A - B)s^2 + (3A - 2B + C)s + A - B + C - D}{(1+s)^4} \end{aligned}$$

Selecting specific values for A, B, C and D allows different transfer functions. For example, selecting A = 1, B = 1, C = 0 and D = 0 transforms the above equation into:

$$\frac{s}{(1+s)^2}$$

This is the transfer function of a 2-pole band pass filter. Getting different responses from this network will be just a matter of adjusting the coefficients A, B, C and D in order to

transform the transfer function into the desired one. For the high pass and all pass filter modes, it is necessary to cancel the first cell of the filter. This is accomplished by opening the switch S1.

In practice, S1 is implemented by one cell of the analog switch UX15, the buffers b1, b2 and b3 are the four op amps of UX13, b4 is the op amp UX15 (output pin 7) and the summation is performed by the second cell of UX15 (output on pin 1.). The coefficients A, B, C and D are set by the value of the summing resistors. The analog multiplexer UX17 allows selection of eight different resistor combinations providing eight different filter modes. Selecting the previous modes and opening S1 obtain seven additional modes.