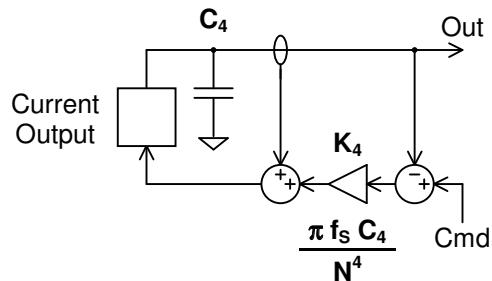


Where:

$$1.4 < N < 2$$

Now the leapfrog method has come full circle to the starting conditions of a controlled voltage source feeding an inductor element in an LC filter ladder. Just as before, this element is incorporated into the system by applying the appropriate amounts of positive and negative feedback. Gain K_3 for this feedback path is set so that closed loop gain is about two thirds of what it was before. The resulting equivalent voltage controlled current source is shown below feeding the next filter element C_4 .

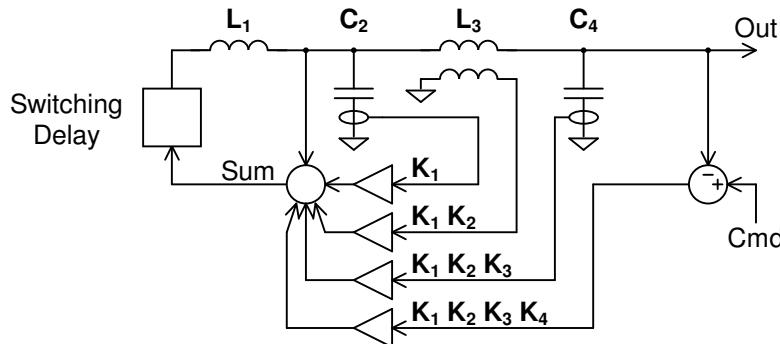


Where:

$$1.4 < N < 2$$

The process continues until all the filter elements are incorporated into the amplifier, yielding a well controlled, component insensitive, switching amplifier with the maximum possible bandwidth. These advantages come at a cost of an extensive feedback network distributed throughout the switching amplifier's recovery filter ladder.

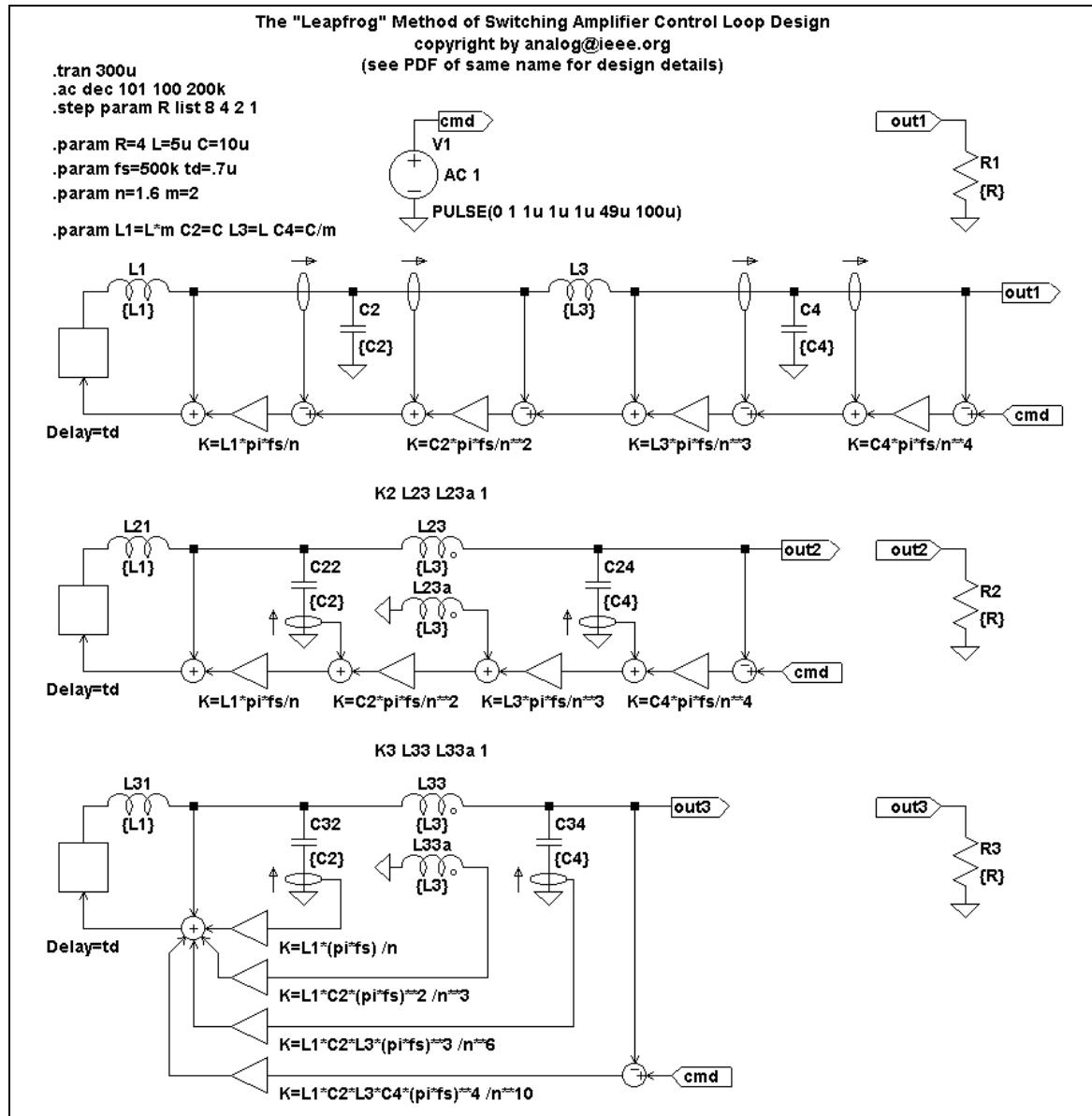
In practice, both the sensing and feedback amplifier circuitry can be greatly simplified by combining adjacent signal paths. In particular, combining stages removes the need to reproduce dc signals in the sensing circuitry. Recognizing that the difference of inductor currents must flow through the capacitor on the common node between adjacent stages justifies using a simple current transformer to sense this difference current. Likewise, recognizing that the difference of capacitor voltages must appear across the interposing inductor justifies using a simple floating winding to sense the difference voltage.



All of the distributed gain terms are easily consolidated into a single summing amplifier by simply accounting for the cumulative gain terms in the path for each signal as shown above.

Following these constructs results in a switching amplifier system that is both practical and simple, yet easily accommodates a recovery ladder filter network of any length within its feedback path.

The following schematics were simulated in LTspice in order to demonstrate and confirm the principles of the leapfrog method of switching amplifier design. As expected, the simulation output from the three variations was absolutely identical, verifying the validity of the topological manipulations.



Typical output from ac frequency response and 10kHz square wave transient response is presented below, with each showing the effect of stepping the load resistor from 1 to 8 ohms. Note that fs represents the effective sampling frequency which may be quite different from the nominal switching frequency. For example, in a free-running, self-oscillating design, the effective sampling frequency would be very close to the lowest switching frequency during dynamic excursions and not the typically 3-to-4-times higher quiescent operating frequency. Likewise td represents the effective worst-case delay rather than the typical delay. Thus, the rather high fs and low td of the simulation would be difficult to achieve in practice unless the design employed multiple, parallel, staggered phase output stages feeding the recovery filter. (This technique multiplies the sampling frequency by the number of staggered phase output stages.)