

BORBELY RIAA PREAMP

The single-stage RIAA amp shown in Fig. 2 has several disadvantages. The feedback network, which provides the RIAA correction, has a varying impedance with frequency. This impedance is lowest at high frequencies, which puts a very heavy load on the amp in the 10 to 20kHz range. Also, because the configuration is noninverting, the gain will flatten out at 1 (or 0dB) even if you reduce the impedance of the feedback network to zero. This tends to give an equalization error around 20kHz.

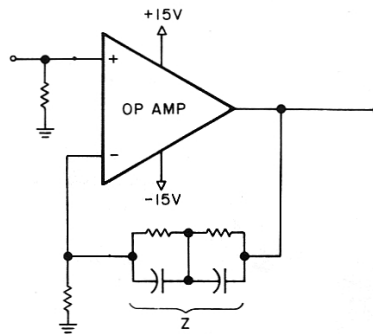


FIGURE 2: Typical noninverting, single-op-amp RIAA amplifier.

We have another problem at low frequencies, where the gain is very high, flattening out at around 54dB below 20Hz. To avoid equalization error, the open-loop gain of the amplifier must be significantly higher than the 54dB closed-loop gain. Traditionally, this was the biggest problem with early transistor RIAA amplifiers. With today's high-gain op amps, this problem is significantly reduced.

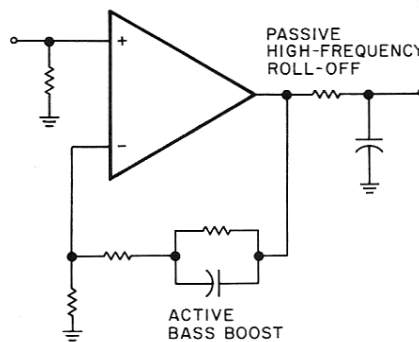


FIGURE 3: A passive high-frequency roll-off alleviates the problem of a low-impedance load.

It is quite difficult to design a very accurate RIAA stage using the configuration of Fig. 2. Fortunately, we can solve two of the problems by removing the 75usec roll-off from the feedback network and replacing it with a passive one as shown in Fig. 3. This circuit removes the burden of low-impedance load at high frequencies and is inherently easier to calculate than the circuit in Fig. 2. The amplifier's open-loop requirement will remain the same as that of Fig. 2, but it introduces a problem of its own. Because of the passive roll-off, it reduces the overload margin at high frequencies. Also, you must consider any load on the output (volume control, tape recorder inputs, and so on) when calculating the 75usec roll-off.

In the past few years, more and more high-end preamps have used a two-amplifier topology for RIAA. You might remember Dick Marsh's circuit from TAA 3/80 (p. 18) in which he used an all-passive RIAA equalization between two gain stages. Walt Jung reported the same

approach at the Audio Engineering Society's 67th Convention.³ Figure 4 shows such a two-stage, passively equalized RIAA amp.

The all-passive approach solves the problem of high-frequency loading, but introduces some new ones. The most important consideration is the choice of gain distribution between the two stages. Low gain in the first stage and high gain in the second eliminates overload, but it means a very low input signal for the second stage, and this might create noise problems. The opposite is good for noise but bad for overload. According to Jung, optimum gain distribution is about 28dB in the input stage and 32dB in the second stage. Marsh opted for a lower gain in both stages of his TAA design.

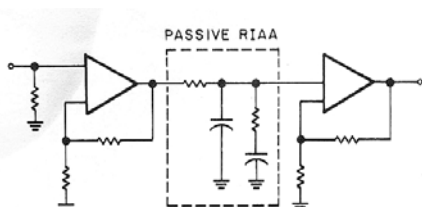


FIGURE 4: Dick Marsh and Walt Jung have written about this type of all-passive RIAA equalization used between two linear gain stages.

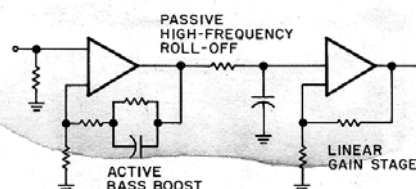


FIGURE 5: A two-stage RIAA amp with active bass boost and a passive high-frequency roll-off.

A different approach, combining the advantages of the circuits in Figs. 3 and 4 is shown in Fig. 5. Also a two-amplifier topology, it retains the passive high-frequency roll-off, but the bass boost is in the feedback loop. The advantage of this circuit is the lower gain required by both amplifiers, which lets you use gain blocks with low open-loop gain. Naturally, the bass boost does not have to be in the input stage. In fact, it is an advantage to put it in the second stage, as Jung suggests,⁴ using two instrumentation amplifiers in a very elegant scheme with true differential input and gain adjustment in the input stage. I have chosen the same two-amplifier topology for my RIAA amp (Photo 2), but decided to stay with discrete circuitry (Fig. 6). The reason for this, in addition to the arguments presented above, is that I rate symmetrical, complementary design very high in terms of listenability. Unfortunately, none of the op amps on the market offers this kind of design.

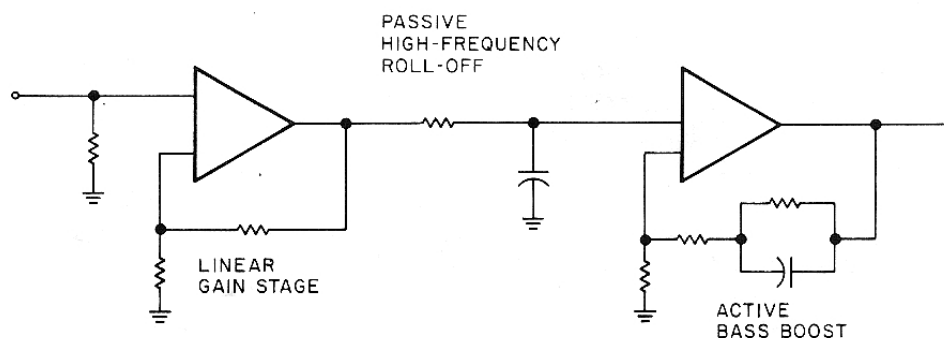


FIGURE 6: Mr. Borbely chose this two-stage configuration with discrete circuitry for his current design.