

## Low Frequency Compensation

A feature of Fig. 2 not discussed so far is a low-frequency compensating circuit,  $R_{F3}$  and  $C_5$ .

Amplifiers of the basic circuit topology of Fig. 2 (theory article) have a group delay which is different for different signal frequencies. Some frequencies take longer or shorter times than others to pass through the amplifier. High-frequency group delay in NDPL amplifiers can be corrected, as described last month, by a small capacitor in the feedback network (See Equation 15). Errors in low-frequency group delay, in both Figures 2 and 10 (theory article) are associated with the input coupling capacitor and the capacitor in series with  $R_{F1}$ . Low-frequency square-wave inputs are reproduced with a 'tilt' as in Fig. 3a.

One approach to this problem is to use a truly direct-coupled amplifier, with no capacitors in series with the signal path; commercial audio power amplifiers of this type appeared in the 1970s. Unfortunately, such amplifiers are prone to drift. A significant DC voltage may appear at the output even when there is no input. Although it is possible to reduce drift in a power amplifier to an acceptable level, it is not possible with today's technology to build a system that is truly direct-coupled from pick-up input, through the RIAA network and the power amplifier.

In the last few years a generation of amplifiers has appeared which include some form of servo amplifier to correct the drift. All circuits known to the author reintroduce the problem of group delay, albeit in a lesser form.

The approach adopted in the design is to retain the coupling capacitors and thereby eliminate drift, but include a group-delay correcting circuit. Figure 4 shows the outline. Group delay is optimally compensated if:

$$R_{F3} = 2R_{F2} \quad (16)$$

$$R_{F2}C_{F2} = R_{F1}C_{F1} \quad (17)$$

Figure 3b shows the improvement in square-wave response.

Low-frequency group-delay compensation could well be included in audio power amplifiers and pre-amplifiers other than NDPL types.

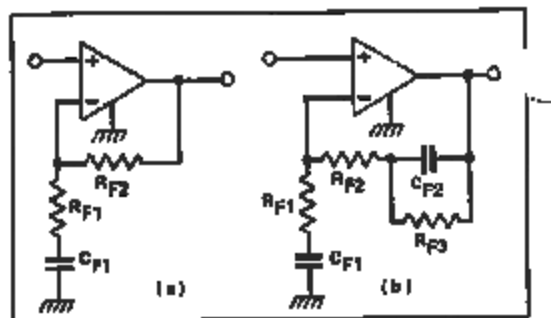
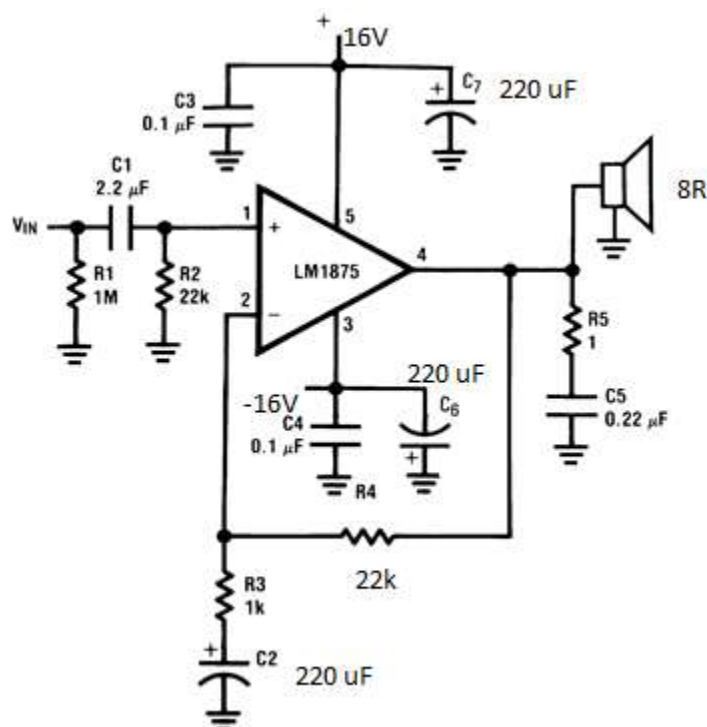


Figure 4 Circuit for compensating low frequency group delay: (a) basic uncompensated circuit; (b) compensated circuit.



My LM1875