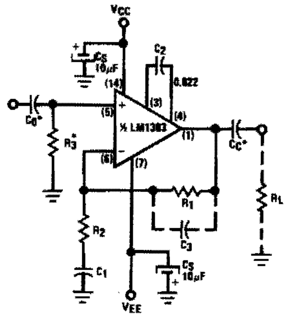
…ting AC Amplifier

…1303 used as a non-inverting amplifier (Figure …with split supplies allows for economical direct- …designs if the DC levels between stages are main- …zero volts. Gain and C_1 equations are shown in the …Resistor R_3 is made equal to R_1 and provides DC …ents to the positive input. Compensation capacitor …ual to 0.022µF and guarantees unity gain stability …slew rate of approximately 1V/µs. Higher slew rates …sible when higher gains are used by reducing C_2 …tionally to the increase in gain, e.g., with a gain of C_2 can equal 0.0022µF, increasing the slew rate to … 10V/µs. Some layouts may dictate the addition of …r added stability. It should be picked according to …ion (2.10.1) where f_H is the high frequency −3dB …r.

$$= \frac{1}{2\pi f_H R_1} \qquad (2.10.1)$$



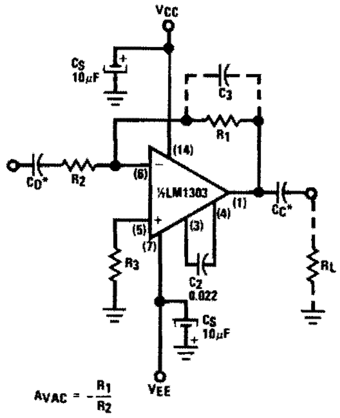
$A_{VAC} = 1 + \frac{R_1}{R_2}$

$C_1 = \frac{1}{2\pi f_o R_2}$ $\quad C_c R_L >> C_1 R_2$, $C_o R_3 >> C_1 R_2$

f_o = LOW FREQUENCY −3dB CORNER

* − MAY BE OMITTED FOR DIRECT-COUPLED DESIGNS.

FIGURE 2.10.1 LM1303 Non-Inverting AC Amplifier



$A_{VAC} = -\frac{R_1}{R_2}$

$C_o = \frac{1}{2\pi f_o R_2}$ $\quad (C_c R_L >> C_o R_2)$

f_o = LOW FREQUENCY −3dB CORNER

* − MAY BE OMITTED FOR DIRECT-COUPLED DESIGNS.

FIGURE 2.10.2 LM1303 Inverting AC Amplifier

2.10.3 Inverting AC Amplifier

For applications requiring inverting operation, Figure 2.10.2 should be used. Capacitors C_2 and C_3 have the same considerations as the non-inverting case. Resistor R_3 is made equal to R_1 again, minimizing offsets and providing bias current. The same slew rate-gain stability trade-offs are possible as before.

2.11 PHONO PREAMPLIFIERS AND RIAA EQUALIZATION

2.11.1 Introduction

Phono preamplifiers differ from other preamplifiers only in their frequency response, which is tailored in a special manner to compensate, or equalize, for the recorded characteristic. If a fixed amplitude input signal is used to record a phonograph disc, while the frequency of the signal is varied from 20Hz to 20kHz, the playback response curve of Figure 2.11.1 will result. Figure 2.11.1 shows a plot of phono cartridge output amplitude versus frequency, indicating a severe alteration to the applied fixed amplitude signal. *Playback equalization* corrects for this alteration and recreates the applied flat amplitude frequency response. To understand why Figure 2.11.1 appears as it does, an explanation of the recording process is necessary.

2.11.2 Recording Process and RIAA

The grooves in a stereo phonograph disc are cut by a chisel shaped cutting stylus driven by two vibrating systems arranged at right angles to each other (Figure 2.11.2). The cutting stylus vibrates mechanically from side to side in accordance with the signal impressed on the cutter. This is termed a "lateral cut" as opposed to the older method of "vertical cut." The resultant movement of the groove back and forth about its center is known as groove modulation. The amplitude of this modulation cannot exceed a fixed amount or "cutover" occurs. (Cutover, or overmodulation, describes the breaking through the wall of one groove into the wall of the previous groove.) The ratio of the maximum groove signal amplitude possible before cutover, to the effective groove noise amplitude caused by the surface of the disc material, determines the dynamic range of a record (typically 58dB). The latter requirement results from the grainy characteristic of the disc surface acting as a noise generator. (The cutting stylus is heated in recording to impart a smooth side wall to minimize the noise.) Of interest in phono preamp design is that the record noise performance tends to be ten times worse than that of the preamp, with typical wideband levels equal to 10µV.

Amplitude and frequency characterize an audio signal. Both must be recorded and recovered accurately for high quality music reproduction. Audio amplitude information translates to groove modulation amplitude, while the frequency of the audio signal appears as the rate of change of the groove modulations. Sounds simple enough, but Figure 2.11.1 should, therefore, be a horizontal straight line centered on 0dB, since it represents a fixed amplitude input signal. The trouble results from the characteristics of the cutting head. Without the negative feedback coils (Figure 2.11.2) the velocity frequency response has a resonant peak at 700Hz due to its construction. Adding the feedback coils produces a velocity output independent of frequency; therefore, the cutting head is known as a constant velocity device (Figure 2.11.2a).

Figure 2.11.1 appears as it does because the cutting amplifier is pre-equalized to provide the recording character-

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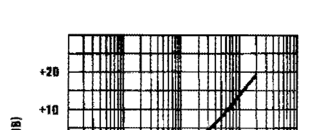

FIGURE 2.11.1 Typical Phono Playback Characteristic for a Fixed Amplitude Recorded Signal

istic shown. Two reasons account for the shape: first, low frequency attenuation prevents cutover; second, high frequency boosting improves signal-to-noise ratio. The unanswered question is why is all this necessary?

The not-so-simple answer begins with the driving coils of the cutting head. Being primarily inductive, their impedance characteristic is frequency dependent. If a fixed amplitude input signal translates to a fixed voltage used to drive the coils (called "constant velocity") then the resulting current, i.e., magnetic field, hence amplitude of vibration, becomes frequency dependent (Figure 2.11.2a); if a fixed amplitude input signal translates to a fixed current, i.e., fixed amplitude of vibration, used to drive the coils (called "constant amplitude) then the resulting voltage, i.e., cutting velocity, becomes frequency dependent (Figure 2.11.2b). With respect to frequency, for a given input amplitude the cutting head has only one degree of freedom: vibrating *rate* (constant velocity = voltage drive) or vibrating *distance* (constant amplitude = current drive).

The terms constant velocity and constant amplitude create confusion until it is understood that they have meaning only for a *fixed amplitude input signal*, and are used strictly to describe the resultant behavior of the cutting head as a *function of frequency*. It is to be understood that changing the *input* level results in an *amplitude* change for constant amplitude recording and a *velocity* change for constant velocity recording *independent* of frequency. For example,

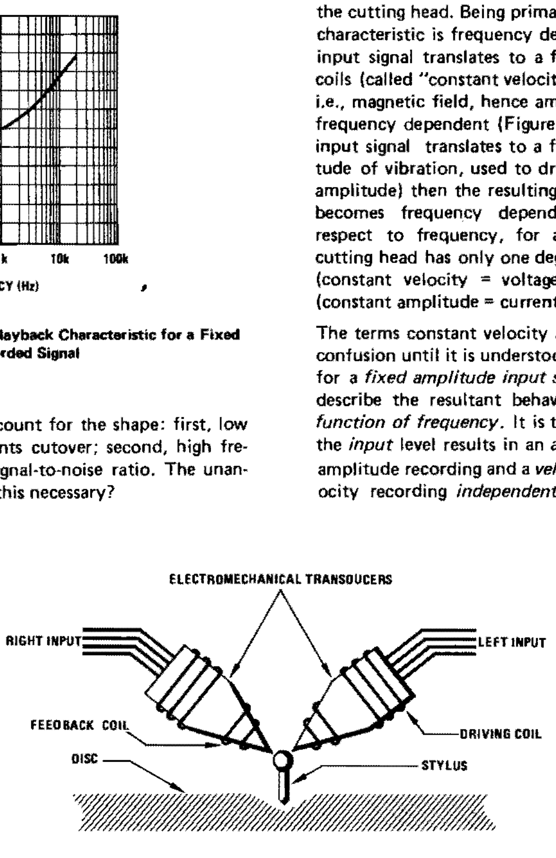

FIGURE 2.11.2 Stereo Cutting Head

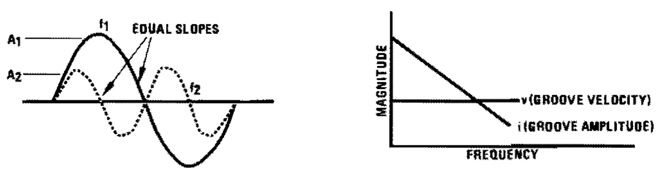

FIGURE 2.11.2A Constant Velocity Recording

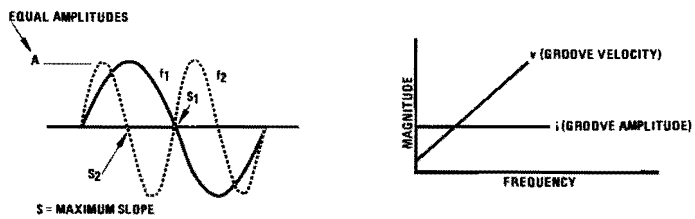

FIGURE 2.11.2B Constant Amplitude Recording