Citation XXP

Citation, 240 Crossways Park West, Woodbury, New York 11797

INTRODUCTION

The CITATION XXP is designed to be the purest, most accurate high fidelity preamplifier available today. It provides precise RIAA equalization and amplification for low level and high level moving-magnet type phono cartridges and flat amplification for high level inputs. In the interest of purity and simplicity, the only features provided are a subsonic filter, input selector switch and level controls.

DYNAMIC PERFORMANCE

The performance of high fidelity components is usually specified in terms of total harmonic distortion (THD), frequency response, rated power, etc. These specifications are based on measurements made with steady-state sine wave input signals.

However, as many listening tests have indicated, excellent steady-state specifications do not guarantee excellent sound quality. That's because excellent steady-state specifications are relatively easy to achieve. Steady-state sine waves are symmetrical waveforms that are relatively slow. They are also pure tones and therefore contain no harmonics.

Music signals, in contrast, are constantly changing in both amplitude and frequency. They can have large, even dominant, harmonic content covering a wide frequency range, with a single waveform.

Because of this, music signals are highly susceptible to a type of distortion that alters the precise relationship between the fundamental tones and their harmonics. This is called Phase Distortion.

It results in a degraded stereo image. And it is this same phase distortion that is the underlying reason why many high-fidelity components (which have excellent steady-state specifications) have been criticized as sounding "two-dimensional."

Fortunately, the problem of Phase Distortion can be solved. The means to do so are directly related to the upper and lower frequency limitations.

AC coupling at a very low frequency limit (such as a fraction of a Hertz) helps to eliminate phase shift. And direct coupling completely eliminates low frequency phase shifts.

High frequency phase shift can be reduced by extending the high frequency response far beyond 20kHz. But circuits with such high upper frequency limits often have other problems, such as ringing and oscillation.

The table below correlates frequency response limitations to phase shift, assuming a simple 6 dB/oct. roll-off.

LOW FREQUENCY LIMIT VS PHASE SHIFT

ATTENUATION AT 20 HZ	LOW FREQUENCY LIMIT (-3dB)	PHASE SHIFT AT 20 HZ
-3 dB	20 HZ	+45°
-2 dB	10.2 HZ	+27°
-1 dB	7.0 HZ	+19.3°
-0.5 dB	4.9 HZ	+13.7°
-0.25 dB	3.4 HZ	+ 9.7°

HIGH FREQUENCY LIMIT VS PHASE SHIFT

ATTENUATION AT 20KHZ	HIGH FREQUENCY LIMIT (-3dB)	PHASE SHIFT AT 20KHZ
-3 dB	20 KHZ	-45°
-2 dB	39.3 KHZ	-27°
-1 dB	57.3 KHZ	-19.3°
-0.5 dB	82.2 KHZ	-13.7°
-0.25 dB	117.0 KHZ	- 9.7°

High frequency non-linearities that produce sonic distortion are another serious problem. In order for a circuit to provide improved quality, the bandwidth must not only be very wide, but the stability and linearity must be maintained.

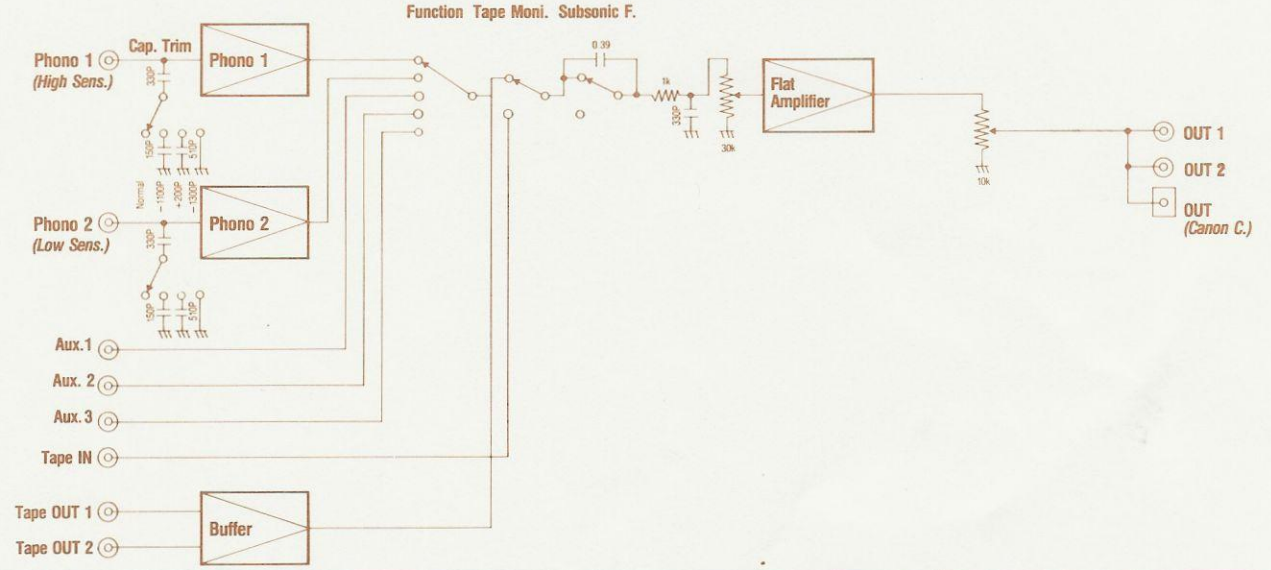
ULTIMATE PREAMPLIFIER CIRCUIT DESIGN

CITATION engineers set out to design the ultimate preamplifier circuitry. After much research and development, they finalized their design and concluded that with some modification, it could be used in both the phono and flat amplifier sections.

The result is a completely symmetrical CLASS A design. It has an ultra-low noise, push-pull FET input and a fully complementary Darlington output. The open-loop (uncompensated) frequency response is DC-300 kHz and uses 20 dB of negative feedback. The power supply voltages to the circuit are ±30V in the phono section and ±20V in the flat amplifier section. Each channel of each section is constructed independently and potted in a resin-epoxy module. The potted module provides temperature tracking and stability between transistors, in addition to protection against contamination.

The basic circuit design of the CITATION XXP is shown in the block diagram (FIG 1.). One stage of amplification and equalization is in the phono sections, while the second stage of amplification is employed after the function selector switch, which all input signals pass through. This second stage of amplification is called the "flat amplifier" or "output amplifier" section. The phono section and the output section share many elements, such as extremely low noise and distortion, excellent transient response, high input impedance, low output impedance, and similar gain (amplification factor).

Figure 1: Cit.XXP Block Diagram



THE IDEAL PHONO PREAMPLIFIER

Because there are so many different performance aspects involved in the reproduction of excellent sound quality, the phono section of a stereo preamplifier is very difficult to design. The ideal phono preamp must include all of the following:

1. Precise RIAA playback equalization
2. Performance that is immune to a high, nonlinear, reactive source impedance.
3. Low, resistive output impedance.
4. Gain (amplification) of approx 30-40 dB (30-100 times)
5. Very low noise
6. High overload level
7. Excellent transient response
8. Excellent linearity (low harmonic distortion)

Yet in many cases design elements conflict with each other. The most popular method of phono section design is the use of a flat, high gain amplifier with negative feedback equalization (FIG. 2A). The problem with this method is that the negative feedback is not constant over the audio frequency range, and is excessive in the high frequencies (FIG. 2B). The effect of this is seriously reduced transient response. Percussive music signals such as cymbals and triangles will seem muted and lacking in detail. Unfortunately, under steady-state tests, this type of circuit performs very well. The good steady-state specs mislead many audio consumers into believing that the circuit has good dynamic performance, as well.

A somewhat less popular method of phono section design is the use of passive equalization: it is accomplished without the use of negative feedback or active (transistor) circuitry. However, the phono section of a preamplifier must also provide gain, and input/output impedance compatibility. Because of this, the passive circuitry must be used in conjunction with active buffer amplifiers at the input and/or output. (FIG. 3) Although these circuits offer greatly improved transient response, they have an inherently inferior signal-to-noise ratio.

DUAL RIAA EQUALIZED PHONO SECTION

CITATION design engineers, fully aware of the positive and negative aspects of both of the basic phono sections described above, developed an alternative. It combines the best aspects of both basic designs, with none of their drawbacks, and provides all eight of the requirements previously stated.

The CITATION XXP phono section has the basic configuration shown in FIG. 4A. The circuitry has both active and passive RIAA equalization, hence the designation "DUAL RIAA EQUALIZED". This Dual RIAA circuit is superior to the more popular NFB EQ circuit in two ways: 1) very little feedback is used, and 2) the amount of feedback is consistent throughout the audio frequency range (FIG. 4B). The result is excellent transient response. And the Dual RIAA circuit also out performs the passive EQ cicuit. The Dual RIAA circuit inherently adds less noise to the music signal than the input and output buffers that must be used with the passive EQ circuit.

FLAT AMPLIFIER (OUTPUT) SECTION

Another vital component of the high fidelity preamplifier is the output section. It provides flat, wideband amplification to whichever source is selected by the function switch; output level control (volume control); and sufficient current and voltage to drive nearly all power amplifiers via a long length of co-axial cable.

Figure 2A: NFB Phono Section

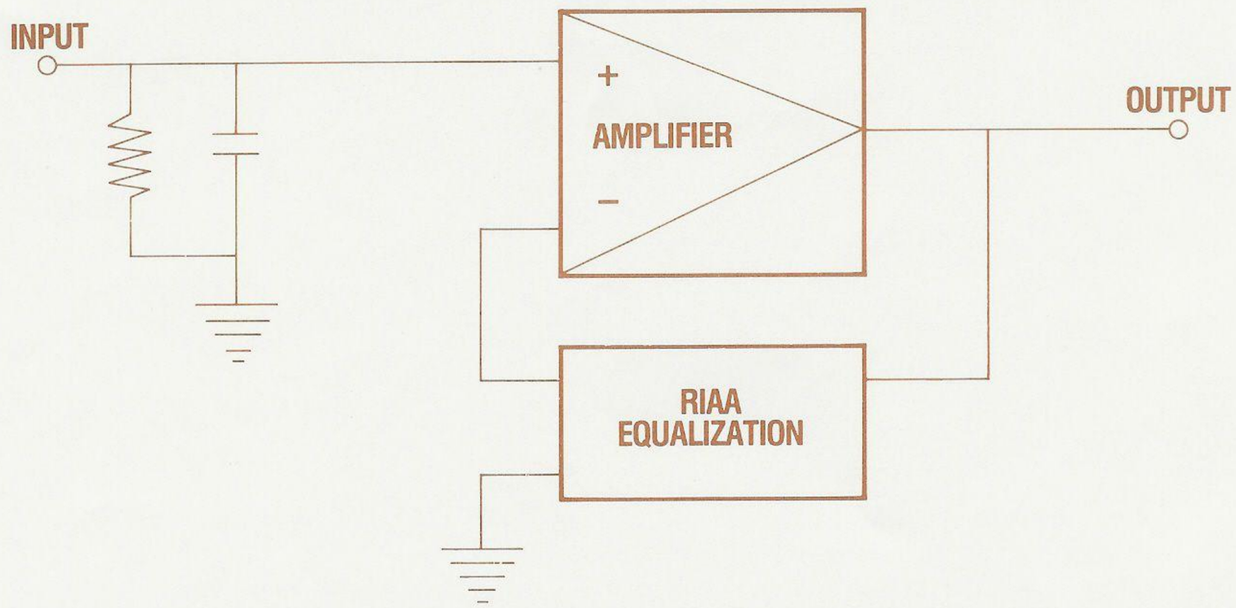


Figure 2B: Amount of Negative Feedback

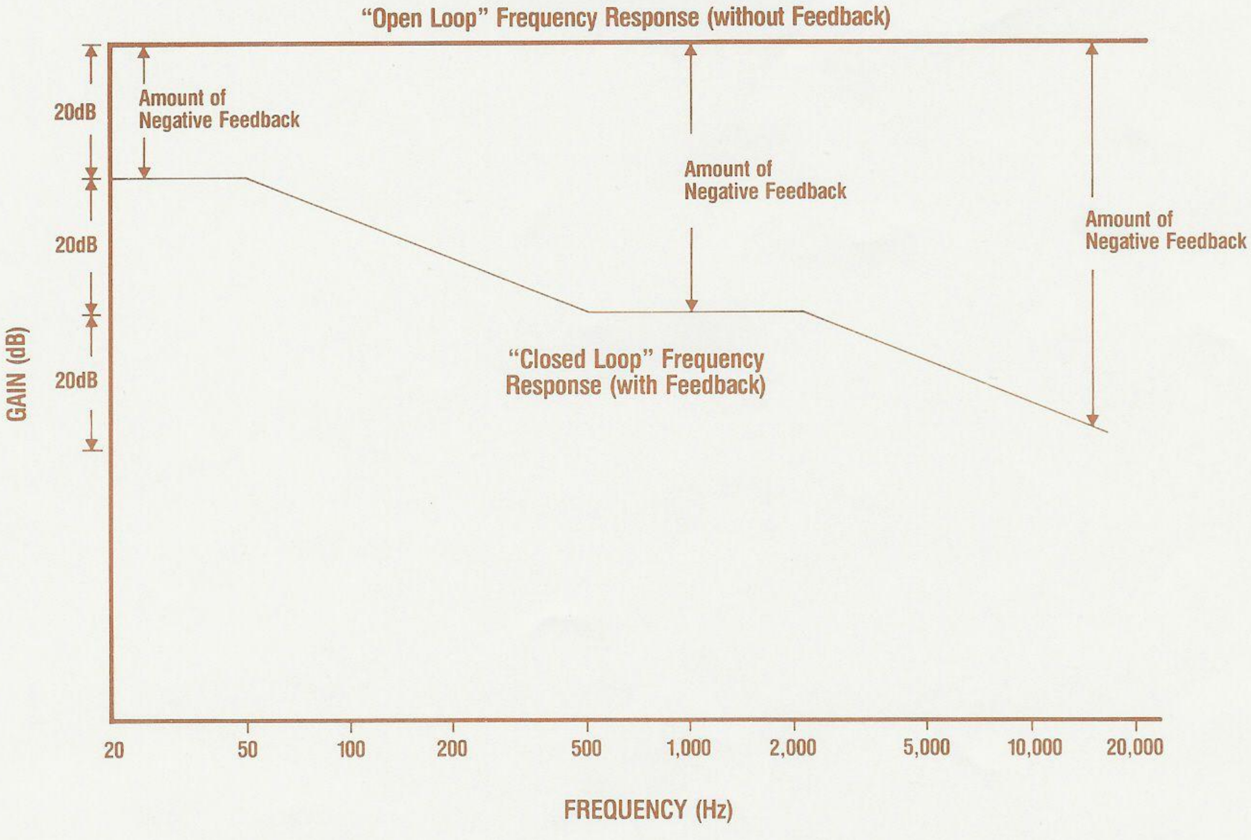


Figure 3: Passive Phono Section

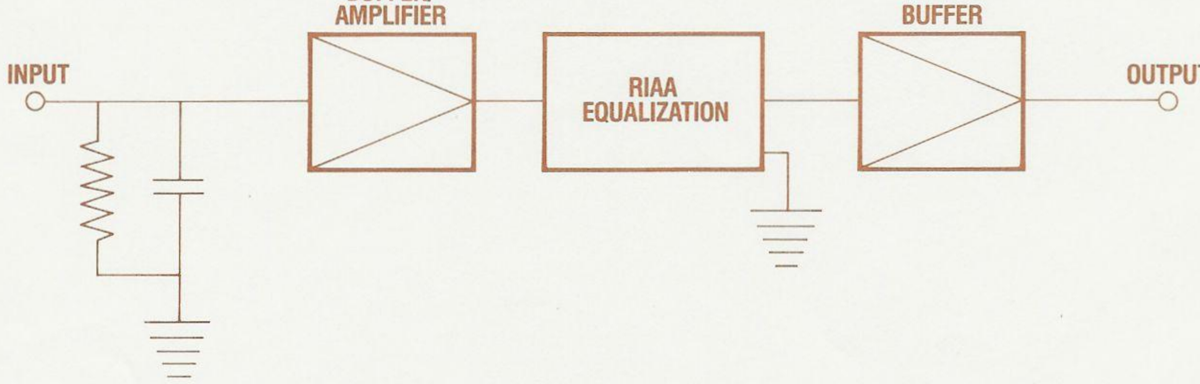
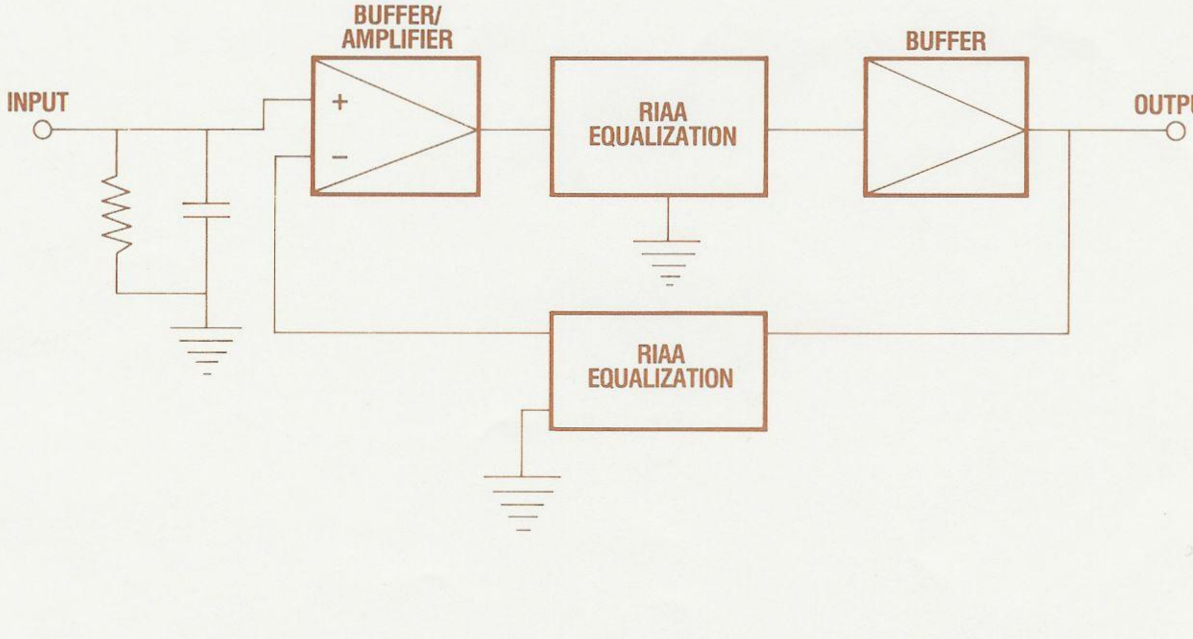
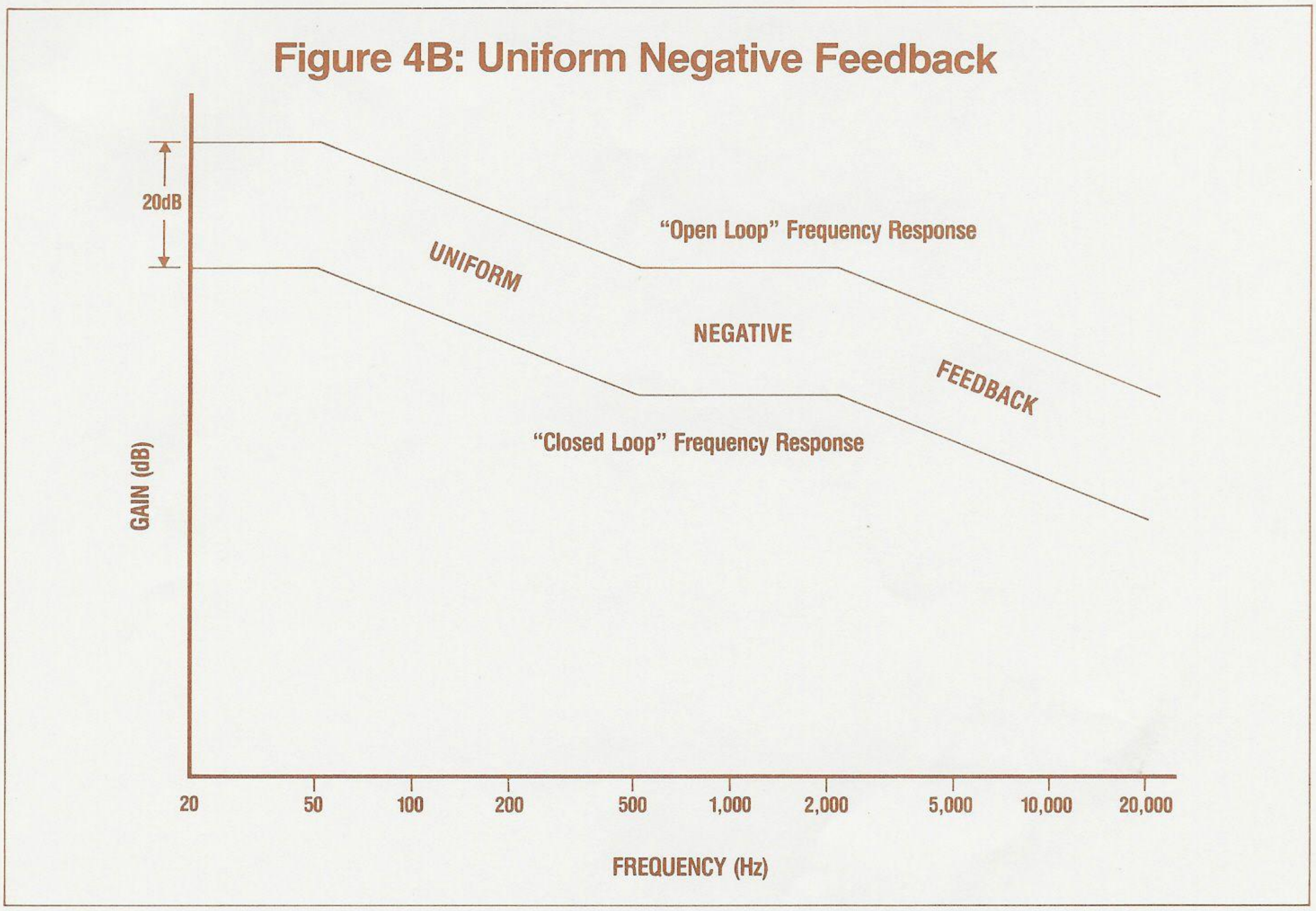


Figure 4A: Dual RIAA Phono Section



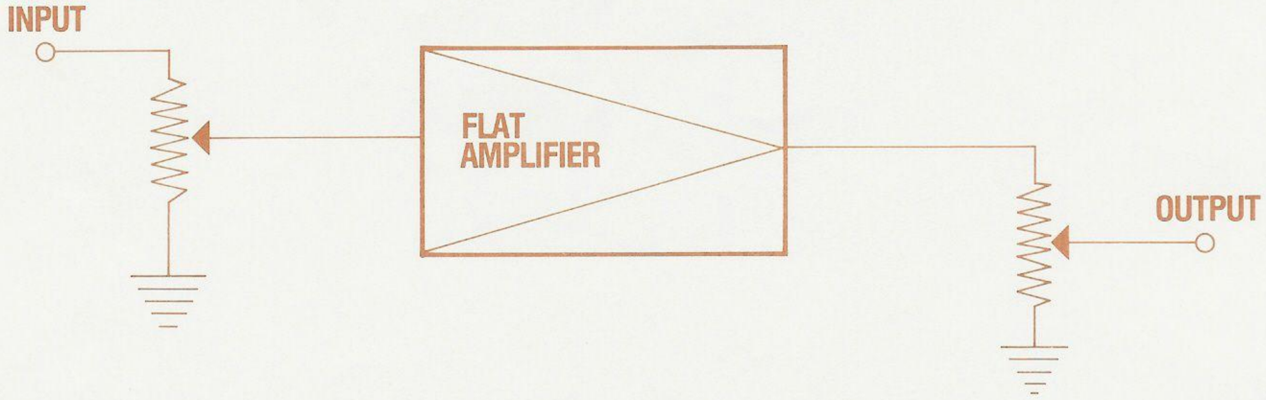


INPUT ATTENUATORS

In order to obtain the best overall performance, the signal level must be as high as possible without overload. In conventional designs, only one level control, labeled "volume," is used. When the level control is put at the input to the flat amplifier, the flat amplifier is protected from overload. (FIG. 5) However, depending upon the output level required, the flat amplifier is not likely to be driven to a high enough level to obtain the best sound quality. The most obvious degradation in sound quality, in this case, is a reduced signal-to-noise ratio.

When the level control is placed at the output of the flat amplifier, it is theoretically possible to drive the flat amplifier very high and obtain excellent sound quality. As the output level is reduced, so is the noise, which maintains the signal-to-noise ratio. However, in this case, the input level to the flat amplifier is determined by one of these elements: 1) the sensitivity of the phono cartridge; 2) the gain of the phono cartridge transformer (if any); or 3) the output level of a tape deck or auxiliary component. It is not likely that the input level to the flat amplifier is the precise level that drives it to just below overload. In this situation, a very high level input would cause

Figure 5: Flat Amplifier w/Input and Output Attenuators



the flat amplifier to overload and the level control could not solve the problem. A weak input signal would not drive the flat amplifier high enough and the sound quality, particularly the signal-to-noise ratio, would suffer.

In the CITATION XXP, an attenuator is used at the input to the flat amplifier, so it can be given the optimum input level. Also, a main output level control (volume control) is located at the output of the flat amplifier. Therefore, even though the flat amplifier is being driven at a high, but optimum level, the output level can be controlled, while the signal-to-noise ratio is maintained.

The CITATION XXP circuit, employing both input and output level control, is a superior, no-compromise design.

POWER SUPPLY SECTION

The power supply of the CITATION XXP, like that of most high fidelity preamplifiers, converts 110-120 volt, 50-60 HZ AC power to DC.

To an extent, the CITATION XXP circuitry is unaffected by irregularities in DC power supplies. However, performance and sound quality are best when power supplies are absolutely stable. For this reason, much engineering effort has been spent on providing DC power to all circuits. The left and right channels of the phone and the flat amplifier sections each have their own independent, dual polarity regulated power supplies (a total of 8 power supplies). With this huge amount of power supply, isolation and capacity, not only is each channel separate, but the phono section and flat amp section of each channel are also independent. Large signals in one channel do not affect the others. The phono sections are not affected by the output level or the impedance load on the output circuitry. The 110-120 volt AC power is converted to the necessary operating voltages by a large toroidal power transformer. This toroidal transformer provides a low impedance to each supply and generates less leakage flux than the conventional, rectangular core transformers. The result is excellent power supply stability and lower hum.

CONSTRUCTION

After the circuits and power supplies were perfected, CITATION engineers still measured and heard minor imperfections in the XXP performance. Interestingly enough, these imperfections were traced to the construction. Therefore, more engineering effort was spent developing a modified construction that would not affect the sound of the circuitry. These are the results of that effort:

The CITATION XXP is enclosed in an EIA standard 3 1/2 inch x 19 inch rack mount chassis. Thick top and bottom plates are used, and each plate is made of a metal chosen for its shielding and grounding capability. The layout of the rear panel jacks, circuit modules, level controls and switches are all located to provide the simplest possible signal path. A sub-enclosure houses the power supply, further reducing hum and noise.

All electrical connections, from the input to output jacks to the connecting terminals between modules, are made via gold-plated surfaces. This insures excellent electrical contact, because gold is immune to the corrosion that affects conventional connectors.

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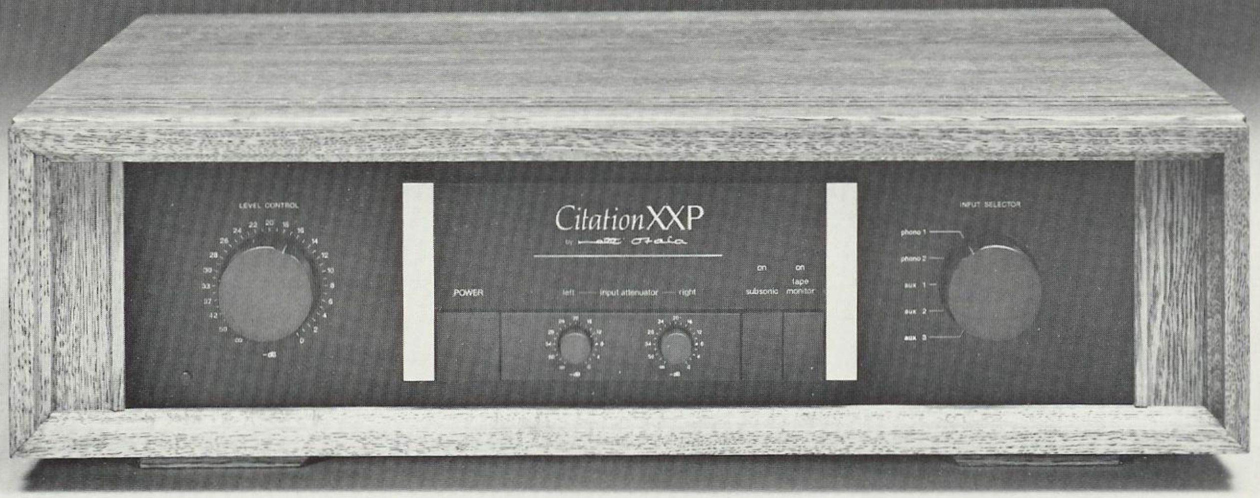
SPECIFICATIONS



INPUT SENSITIVITY/IMPEDANCE	
Phono 1:	1.6mV/47k Ohm, 120 pf
Phono 2:	3.2mV/47k Ohm, 120 pf
Aux/Tape Play:	100 mV/27k Ohm
INPUT OVERLOAD LEVEL	
Phono 1:	220 mV
Phono 2:	440 mV
Aux/Tape Play:	750 mV
OUTPUT LEVEL:	1 Volt (Nominal), 10 Volts (Max)
SIGNAL-TO-NOISE RATIO (A-WTD/UNWTD)	
Phono 1:	82dB/74dB
Phono 2:	84dB/76dB
Aux/Tape Play:	94dB/90dB
FREQUENCY RESPONSE	
Phono (RIAA Accuracy):	20 Hz-20k Hz, ±0.15dB
Aux/Tape Play:	0.1 Hz-300k Hz to ±3dB (Output Level Max.) 0.1 Hz-100 Hz 3 ± dB (Worst Case: Output Level −6dB, 1000 pf Capacitive Load)
SUBSONIC FILTER CHARACTERISTICS:	−3dB at 15 Hz, 6dB/Octave Slope

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