

Project Design Report: Professional Microphone Pre-Amplifier

DOC-CHAI'S AUDIO

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Project Abstract

Our project will be the design of a low-noise microphone pre-amplifier for use with professional studio microphones from companies such as Neumann, Gefell, Shure, etc. This unit would provide the essential functions of a single channel strip from the modern mixing console. Specifically, the pre-amp will provide greater than 40dB gain over the audible frequency range of 35-20kHz within 3dB, phase inversion switch, switchable 48V phantom power for studio condenser mics, balanced inputs and outputs, transformer coupling, discrete input stage, and high signal-to-noise ratio and headroom. To aid in the design goals, a custom linear power supply will be constructed as well.

Features

Our low noise microphone pre-amplifier will fit well in the niche market for true analog designed microphone pre-amplifiers, providing the basic needs of a microphone pre-amplifier while introducing as little noise as possible at a reasonable cost. The design will include the following features:

- Power Supply where the expected range is +/- 15 to +/- 24 V output and 48 V output for "phantom power" for studio condenser microphones.
- Transformer Coupling between XLR inputs and outputs.
- Balanced inputs and outputs, differential signaling for high common mode rejection ratio (CMRR).
- A Phase polarity switch will be included to keep within the high standards of

- professional mic pre-amps.
- Optimum discrete op-amp or input circuit design which minimizes the noise level at the input (equivalent input noise).
 - The bandwidth will be at least 35 Hz to 20 kHz with a tolerance of +/- 3 dB and an available adjustable gain greater than 40 dB for the microphone signal.

Components

In order to provide our features we will have to design a separate power source that can be plugged into the wall (120 VDC/60 Hz) from the main unit that will hold the circuitry for the low noise microphone pre-amplifier, gain control, phase inverter, and XLR inputs and outputs. Since we are trying to make our microphone pre-amplifier as professional as possible, we will use the highest quality parts to ensure the least amount of introduced noise into our system.

For designing the power supply, making sure it could provide the correct outputs were the main concerns. We will use toriodal transformers to make sure the power supply is stable. The connection with the microphone pre-amplifier will be made with a four pin XLR for +/- signals, ground, and 48V “phantom power”. We will use gold plated components for better noise reduction as well. The chassis of the power supply will be made to be big enough to house the transformers for the +/- signals and 48V “phantom power” signal, and regulatory circuitry. We will design the regulatory circuitry to convert the supplies to 4 pin XLR to be connected to the microphone pre-amplifier as well as designed to block some noise from spreading from these supplies.

For designing the circuitry of the microphone pre-amplifier, we will use metal film resistors (1% variation), film capacitors (as well as ceramic and electrolytic), and matched transistors which will help in minimizing variations in the components. This will allow for less noise to be introduced from these components on the PCB. XLR connectors will be used as the input and output for the microphone pre-amplifier. Professional microphones are typically low-impedance types using XLR connections utilizing differential signaling. In order to be combatable with these products, Audio Engineering Society (AES) standards must be met.

The chassis for the microphone pre-amplifier will be made to professional standards by being able to fit into a 19 inch rack taking up two vertical places in the overall rack itself (make diagram of this). We will also use high quality pots and/or switches either from Alps, Grayhill, or Elma. These will give precision control in adjusting the gain to the same position over and over again making it last over a longer time.

The Competition

Some of the similar products available are Neve 1073 (reissue and vintage units), API 512 and 3124, RND Portico 5012, and the John Hardy M1. Each of these units are extremely popular among our market and are all top of the line. These and similar microphone pre-amplifier designs have been used by major recording artists from the late 1960's up to the present.



Figure 1: Two channel AMS/NEVE 1073 DPD Stereo MicPreamp

Technical Concepts

There are three main technical objectives that must be overcome in order to achieve our design features. The first and most important objective is to produce low overall noise for the microphone pre-amplifier. Low overall noise will be at the core of the design of each of the sub-systems of the microphone pre-amplifier. There are two totally different aspects of this concept in order to achieve the overall goal of low noise. The first aspect is to minimize the Equivalent Input Noise (E.I.N). This is the fundamental or "true" noise of the electronic design based around the internal noise generators, both voltage and current, in all active and non-ideal passive components. Optimizing circuit bias points and source resistances, as well as the use of negative feedback, can aid in meeting low noise goals. The second aspect is to minimize the coupling of external noise sources to the internal amplification circuitry; this includes the

use of specialized shielding, grounding, PCB design techniques and balanced differential signaling.

The second objective is to ensure feedback stabilized circuitry. Negative feedback at DC will force optimum bias points for transistors and related components. Negative feedback applied at AC will make the circuit gain and bandwidth less sensitive to changes in temperature, transistor variations, and signal levels.

The third objective is to establish low distortion from the circuitry. While distortion is sometimes considered a musically pleasing effect, for our design we will primarily try to minimize non-linearity with the hope that the quality of the transformers will be the limiting factor. Transistor linearity will benefit from localized feedback (degeneration) as well as the use of overall, global, negative feedback.

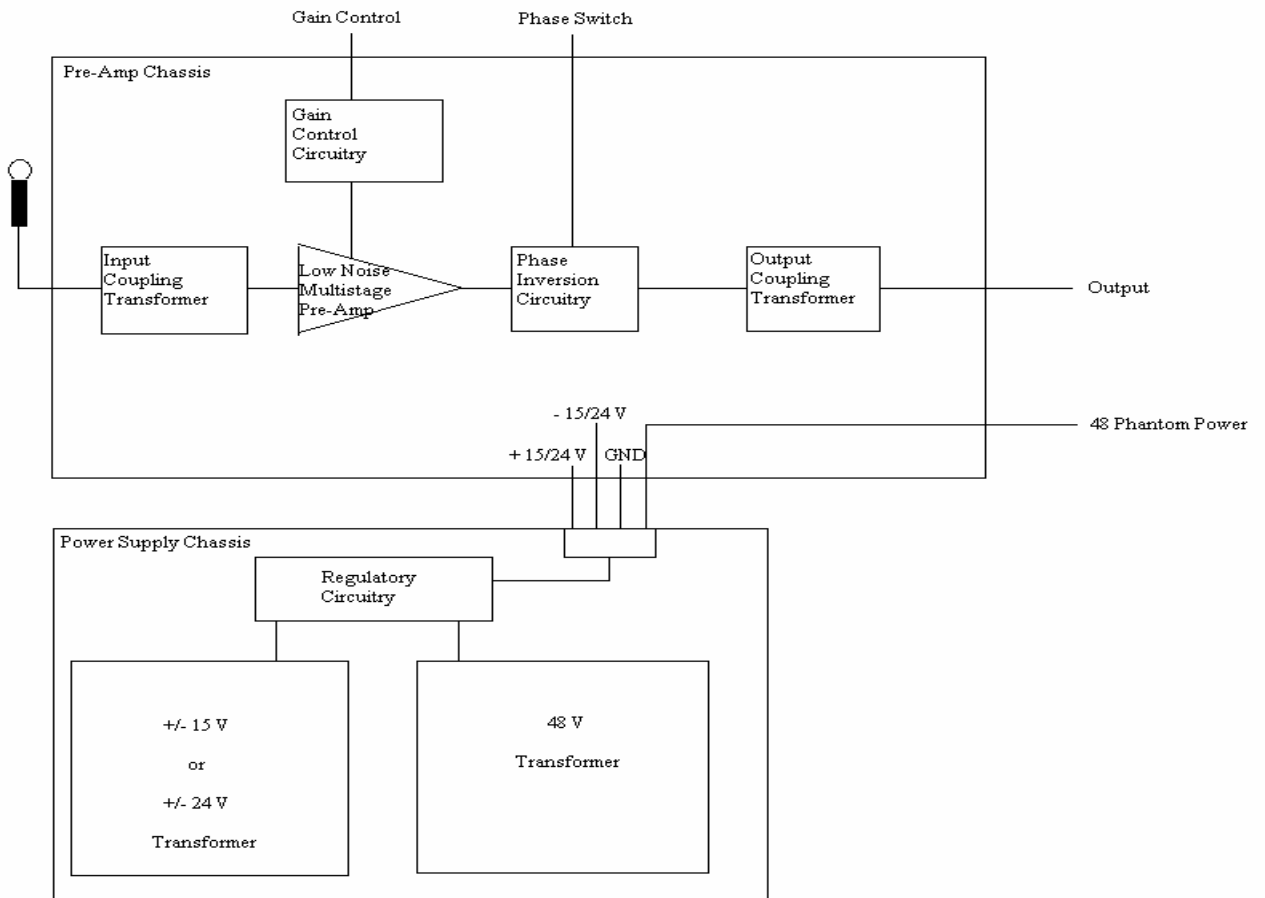


Figure 2: Hardware flow chart from input to output

Division of Labor

The following table shows how the work load was distributed to complete the work load.

Joe	Chris
Power supply design	Power supply design
Building prototype designs	Discrete input stage for amp
Chassis construction	Building prototype designs
PCB design layout	PCB design layout
Constructing PCBs	Constructing PCBs
Integrating systems of the design	Integrating systems of the design
Testing/Debugging	Testing/Debugging

Timeline

We hope to keep to the following schedule for our project design, testing, and building.

