ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF BIOMEDICAL ENGINEERING

III Semester

BM3301 SENSORS AND MEASUREMENTS

UNIT – 4

4.2 Pre-amplifiers

- The purpose of a preamp is to amplify low level signals to line level, i.e. the "standard" operating level of your recording gear. Microphone signals are usually way below the nominal operating level, so a lot of gain is required, usually around 30-60 dB, sometimes even more.
- An ideal preamp will be linear (have a constant gain through its operating range), have high input impedance (requiring only a minimal amount of current to sense the input signal) and a low output impedance (when current is drawn from the output there is minimal change in the output voltage).
- It is used to boost the signal strength to drive the cable to the main instrument without significantly degrading the signal-to-noise ratio (SNR).

Example

i. The integrated preamplifier in a foil electret microphone.
ii. The first stages of an instrument amplifier, which is then sent to the power amplifier. With instrument amplifiers, the preamp is often designed to produce overdrive or distortion effects.
iii. A stand-alone unit for use in live music and recording studio applications.

Here are some key functions and features of preamplifiers:

1. ***Signal Amplification***: The most fundamental function of a preamplifier is to amplify weak signals. This is especially important when dealing with sources such as

microphones, musical instruments, or certain audio/video components that produce signals with low voltage levels.

2. ***Signal Conditioning***: Preamplifiers may include equalization controls (treble, bass, etc.) to adjust the frequency response of the signal. They can also provide tone control or other processing features to shape the sound according to the user's preferences.

3. ***Input Selection***: Preamplifiers often have multiple input channels, allowing users to connect various audio sources (e.g., CD players, turntables, microphones) and switch between them.

4. ***Phono Preamp***: In the context of audio systems, a phono preamp is a specialized type of preamplifier designed for turntables. It boosts the low-level signal produced by a turntable's cartridge to a level that can be processed by a standard preamp or amplifier.

5. ***Volume Control:*** Preamplifiers typically include a volume control to adjust the output level of the signal before it is sent to the power amplifier.

6. ***Low-Noise Operation***: Preamplifiers are designed to operate with minimal added noise to the signal. This is crucial, especially when dealing with low-level audio signals, to preserve signal quality.

7. ***Balanced and Unbalanced Inputs/Outputs***: Preamplifiers may offer both balanced and unbalanced input and output connections. Balanced connections help reduce interference and noise in long cable runs.

Applications:

In biomedical devices, preamplifiers play a crucial role in the acquisition and processing of weak electrical signals generated by biological sources, such as physiological sensors, electrodes, or other transducers. These devices are essential for converting these minute signals into a form that can be further processed, analyzed, and displayed. Here are some specific applications of preamplifiers in biomedical devices:

1. ***Electrocardiography (ECG) and Electroencephalography*** (EEG): In devices used for monitoring the electrical activity of the heart (ECG) or the brain (EEG), preamplifiers are employed to boost the weak electrical signals detected by the electrodes attached to the skin or scalp. This ensures that the signals are of sufficient strength for subsequent processing and analysis.

2. ***Electromyography (EMG***): In EMG devices, which measure the electrical activity of muscles, preamplifiers are used to amplify the small electrical signals produced by muscle contractions. This is especially important for detecting and analyzing the subtle electrical changes associated with muscle activity.

3. ***Biopotential Amplification***: Preamplifiers are used in various bioelectric signal acquisition systems, including those for measuring signals such as electrocardiograms (ECG), electroencephalograms (EEG), electromyograms (EMG), and more. These preamplifiers help maintain the fidelity of the acquired signals and reduce noise interference.

4. ***Bioimpedance Measurements***: In devices that measure bioimpedance, preamplifiers are employed to amplify the small changes in impedance that occur in response to physiological changes. Bioimpedance measurements are used in applications such as impedance cardiography and bioimpedance spectroscopy.

5. ***Neuroprosthetics***: In neuroprosthetic devices that interface with the nervous system to restore lost functionality, preamplifiers are often used to amplify and process neural signals recorded from electrodes implanted in the nervous tissue.

6. ***Biomedical Sensors***: Various biomedical sensors, such as those used to monitor glucose levels, pH, or other biochemical parameters, may produce weak electrical signals. Preamplifiers can be employed to ensure accurate and reliable signal acquisition from these sensors.

7. ***Low-Noise Operation***: Similar to audio preamplifiers, low-noise operation is critical in biomedical preamplifiers to ensure that the weak biological signals are not contaminated by additional electronic noise during the amplification process.

Types of preamplifiers:

- Current-sensitive preamplifier
- Parasitic-capacitance preamplifier and
- Charge-sensitive preamplifier.

Preamplifier will deliver a cleaner, more accurate signal, with higher gain, lower noise, less distortion, and more.