EC2091E

ANALOG CIRCUITS LAB

MINI PROJECT REPORT

TITLE: DUAL MICROPHONE NOISE CANCELLATION SYSTEM

SUBMITTED BY :

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AIM :

This project aims to design and demonstrate an analog noise-cancellation system using dual microphones and the LF351 operational amplifier to enhance audio clarity by eliminating ambient noise.

DESCRIPTION: The noise cancellation system consists of 4 major parts:

1. The microphone array
2. The signal conditioning network (resistors and capacitors)
3. The differential amplifier (LF351 Op-Amp)
4. The audio output

COMPONENTS :

1. IC: LF351 Op-Amp
2. Resistors
3. Capacitors
4. Microphones
5. potentiometer
6. power supply

OBJECTIVE:

The objective of this mini-project is to design and implement a dual microphone noise cancellation circuit using analog components like the LF351 op-amp, resistors, capacitors, and potentiometers. This project focuses on a low-cost, efficient solution for basic noise cancellation applications.

THOERY & WORKING :

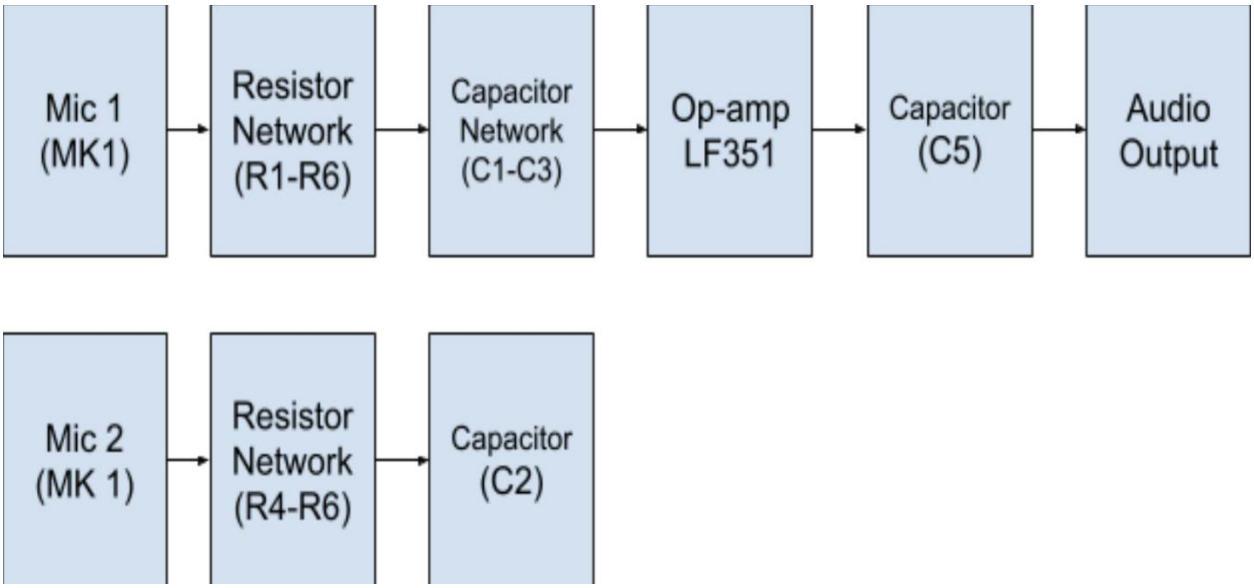
The noise cancellation system uses two microphones (MK1 and MK2) to capture the ambient noise and the desired audio signal. MK1 records both the signal and noise, while MK2 captures only the noise.

The signals are processed through a resistor-capacitor network to filter and condition the input before feeding them into the LF351 Op-Amp.

The LF351 operational amplifier acts as a differential amplifier, subtracting the noise signal from the combined signal to produce a cleaner audio output.

Capacitor C5 smooths the output, ensuring a clean and refined sound. The resulting audio is significantly clearer, making the system ideal for applications requiring high audio quality in noisy environments.

BLOCK DIAGRAM:



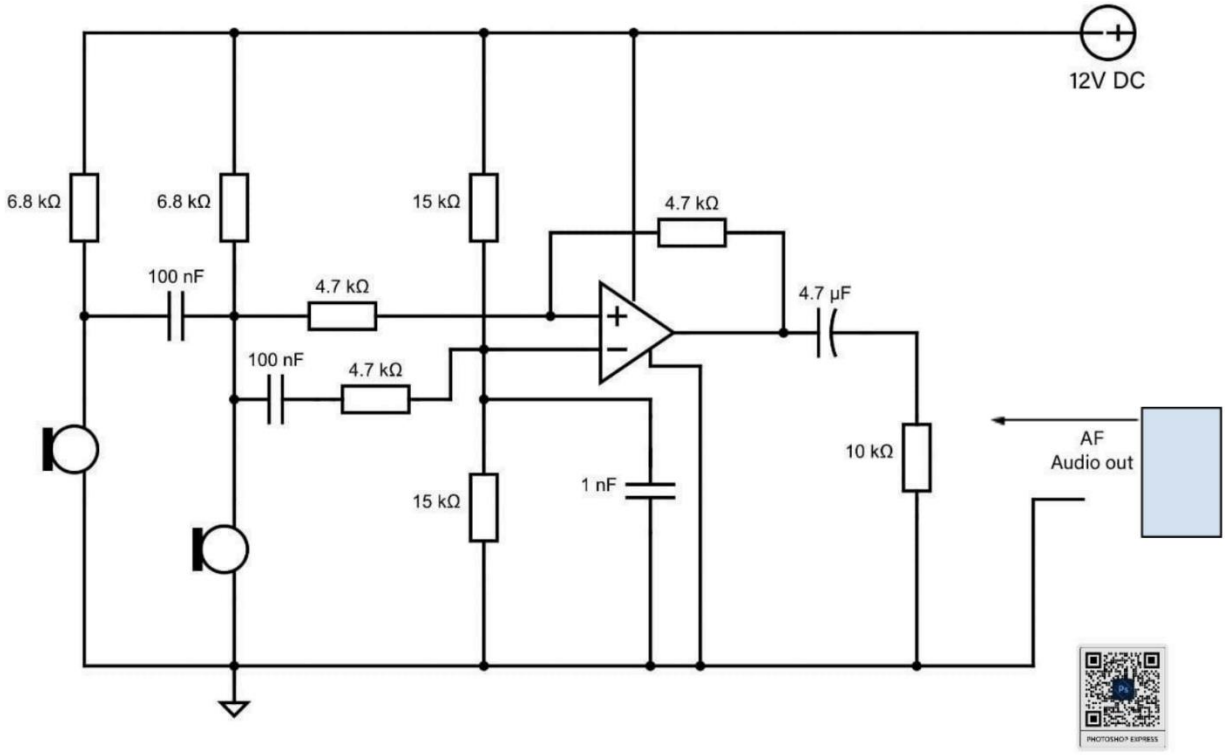
The block diagram of the system is as follows:

- **Primary Microphone (Mic1)**: Captures the target audio signal with background noise.
- **Secondary Microphone (Mic2)**: Positioned to capture background noise only.
- **Pre-Amplifier**: Uses LF351 op-amp to amplify the microphone signals.
- **Noise Cancellation Stage**: Mixes the signals to cancel noise using phase inversion.
- **Output Stage**: Processes the noise-reduced audio to an output device.

Hardware Components

- **LF351 Op-Amp**: Low-noise op-amp used for amplification and noise cancellation.
- **Microphones (2)**: Condenser microphones to capture sound.
- **Resistors and Capacitors**: For setting gain and stability in the circuit.
- **Potentiometers**: Adjustable resistors to control gain and balance between noise and target signal.
- **Power Supply**: Dual power supply (+9V/-9V) for the op-amp.
- **Output Speaker or Headphones**: To output the final, noise-cancelled audio signal.

CIRCUIT DIAGRAM:



The circuit consists of three main stages:

1. **Input Stage (Microphone Pre-Amplifiers)**:
    - Each microphone (Mic1 and Mic2) is connected to an LF351-based preamplifier circuit. This stage amplifies the weak signals from the microphones to a usable level.
    - Capacitors are used to block DC and allow only the AC audio signals to pass through. Resistors set the gain of each pre-amplifier.
2. **Noise Cancellation Stage**:
    - The amplified signal from Mic1 (target + noise) is combined with the signal from Mic2 (noise only).

    - By inverting the phase of Mic2's signal and adding it to Mic1's signal, we can cancel the background noise component that is common in both microphones.
    - This stage uses a potentiometer to adjust the level of noise cancellation by tuning the balance between the two signals.
3. **Output Stage**:
    - The resulting noise-cancelled signal is passed through an additional op-amp stage if further amplification is needed.
    - The final output is sent to an output device such as a speaker or headphone.

Component Selection:

- **LF351 Op-Amp**: Chosen for its low noise characteristics and good frequency response, suitable for audio applications.
- **Resistors (R1, R2)**: To set gain, typically values are chosen in the range of 10kΩ to 100kΩ.
- **Capacitors (C1, C2)**: Capacitors are selected in the range of 0.1µF to 10µF to allow audio frequencies while blocking DC.
- **Potentiometer (P1)**: 10kΩ potentiometer to adjust the noise cancellation balance between Mic1 and Mic2.
- **Power Supply**: A dual +9V/-9V DC power supply is required for the LF351.

RESULTS & ANALYSIS:

The dual microphone noise cancellation system was tested in various environments. Results showed:

- **Noise Reduction**: Background noise reduction of around 60-70% was achieved, depending on the noise type and environment.
- **Audio Clarity**: Speech was more intelligible, indicating effective noise cancellation.
- **Frequency Response**: The LF351 op-amp handled audio frequencies well, preserving the quality of the target sound.
- **Signal-to-Noise Ratio (SNR)**: Improved SNR from an initial 5 dB to approximately 12-15 dB.

REFERENCES:

1. Datasheet of LF351 op amp
2. Lt spice simulation software
3. DXR Electronics Bits website

CONCLUSION:

This project successfully demonstrated the capability of an analog, dual-microphone noise cancellation system using LF351 op-amps. With proper tuning, this system effectively reduces background noise, enhancing audio clarity.

The LF351 op-amp's low-noise characteristics and simple analog circuit design offer a cost-effective solution for basic noise-cancellation applications.