LED VU Meter with Audio Amplification

Electrical Circuits Lab (EE1200) Project

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Abstract

Volume Unit (VU) Meter is a device that is used to visualize the intensity of sound. An audio amplifier increases the intensity of the audio signal. This lab project aims to construct a VU meter that visualizes the intensities using LEDs. It is integrated with an audio-amplifier that simultaneously plays the amplified music from an audio source, such as a laptop.

I. Aim of the Experiment

This project aims to construct the circuits of an LED Volume-Unit meter and audio-amplifier and integrate them. The combined circuit outputs the audio signal as well as visualizes its frequencies using LEDs.

II. Introduction

VU meters find a wide range of applications in the field of sound engineering. It is used extensively in recording studios, radio stations, sound reinforcement, audio equipment and DJ equipment. The aim here is to create a beautiful way of visualizing audio intensities through an LED array and provide a reliable way of measuring audio intensities. As an additional feature, the circuit also integrates an audio-amplifier that plays the audio to enable one to observe the correspondence between the audio and visual output.

III. Components Used

For the VU Meter:

1) Green LEDs (× 12)
2) Yellow LEDs (× 21)
3) Red LEDs (× 30)
4) BC 547 Transistor (× 10)
5) LM 3914 IC
6) 33k Resistor
7) 1.5k Resistor
8) Audio Jack

For the Audio-Amplifier:

1) LM 386
2) 100 μF capacitor
3) 104 pF capacitor
4) 10 μF capacitor (× 2)
5) 4.7 nF capacitor
6) 220 μF capacitor
7) 10 Ω Resistor
8) 10 kΩ Potentiometer
9) Speaker

IV. Circuit Diagram

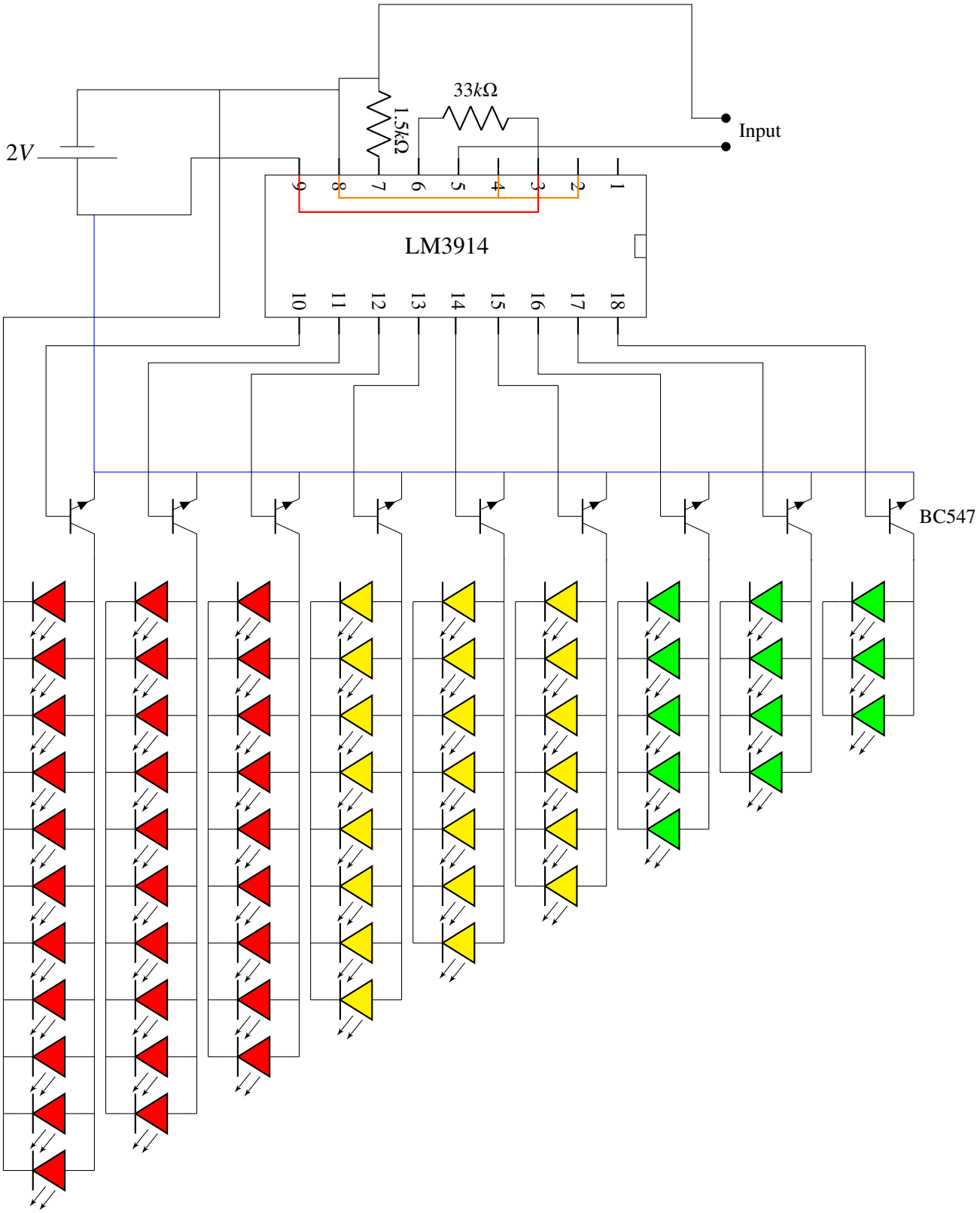


Fig. 1: VU Meter Circuit

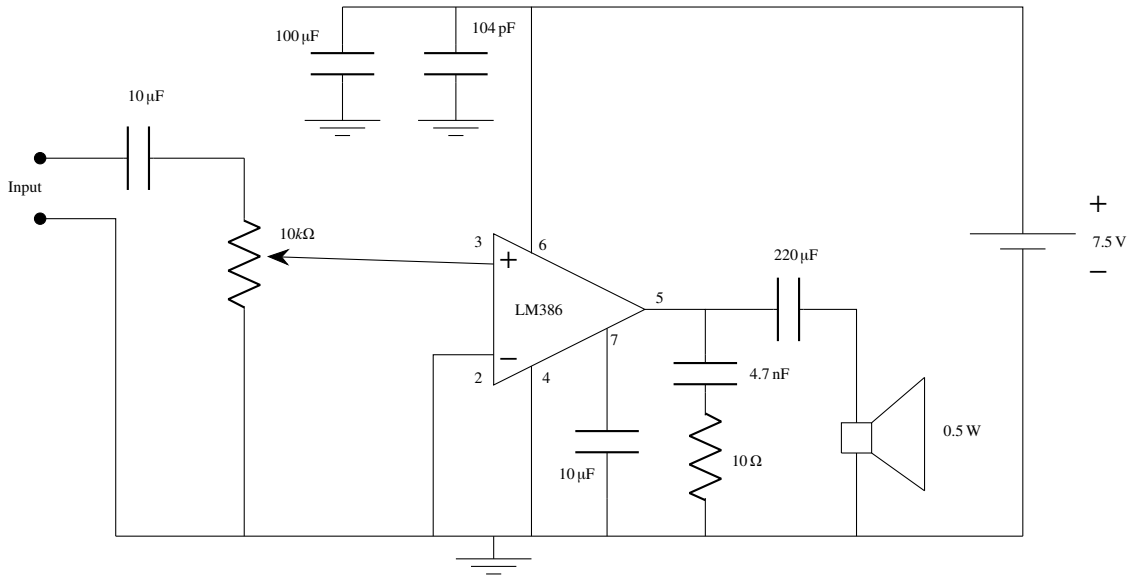


Fig. 2: Audio-Amplifier Circuit

V. Connections of the Circuits

A. *The Volume-Unit Meter*

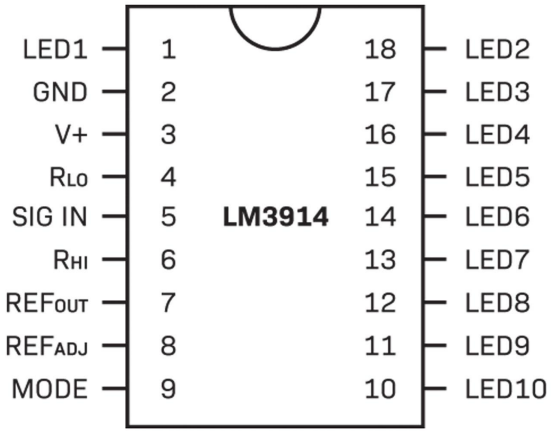


Fig. 3: LM3914 Pinout Diagram

1) **Input**: The VU meter circuit takes in input from laptop through an audio jack. The ground pin of the audio jack is connected to PIN 8 (*Reference* PIN) of the LM3914 IC. The positive input wire of the jack is connected to PIN 5 which is the *Signal Input* PIN of the IC. Volume of the sound input is adjusted on the laptop, and the effects of this adjustment is immediately visible in the working of the circuit.

2) **The LM3914 IC**: The LM3914 IC is an IC mainly used to visualize the intensity of audio signals. This visualisation is generally though an array of LEDs, which we have, in fact, used in this project. A single IC can drive upto 10 rows of LEDs; we have 9 in our circuit for symmetry. The specialization of this IC is that its output is displayed in a linear scale (which helps in better visualization of audio obtained from usual songs/music). To display in logarithmic or semi-logarithmic scales, we could have used LM3915 or LM3916 respectively, but we chose to go with a linear scale for the reason

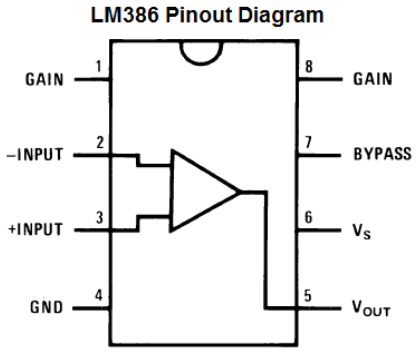
mentioned previously.

The properties of this IC which make it preferable are given below:

- Can drive an array of LEDs, LCDs and vacuum fluorescents.
- Internal Voltage reference (Voltage between PIN 7 and PIN 8) is adjustable from 1.2V to 12V
- Can operate with input voltage $\leq$ 3V. We have used 2V in the circuit to balance between the requirements of the different colored LEDs.
- Output current can vary between $2mA$ to $30mA$, which is suitable for our row that contains maximum (11) LEDs.
- There is no interaction between outputs; they are independent of each other, which ensures that the LEDs light up suitable depending only on intensity of the input sound.

The $1.5k\Omega$ resistor connected between PIN 7 and ground (PIN 8) determines the brightness of the LEDs by controlling the current that flows through each of them. This value of the resistor ensures that the brightness is suitable for all LEDs.
The $33k\Omega$ resistor, connected between PIN 3 and 6, is used as a voltage divider. It determines the voltage given to the internal comparator circuits.
An input voltage of 2V is given between PINs 8 and 9.
The LED arrays are connected to PINs through 10 through 18.

B. *The Audio Amplifier Circuit*



1) **Input**: The Audio-Amplifier circuit takes input from laptop via audio jack. The input signal is passed through a high-pass filter to remove any DC components (noise) in the signal. This signal is then passes through a potentiometer (used to control volume of output audio) into PIN 3 (+ INPUT) of the LM386 IC.
PINs 2 and 4 are connected to ground and PIN 6 ($+V_s$) to the input voltage (8V).
Capacitor filters (100 μF and 104 pF) are connected across the source to maintain a constant voltage input and neutralise any sudden highs or lows in the input source.
PIN 7 is the bypass PIN, that reduces noise in the output signal. This noise occurs because the op-amp is not ideal, i.e., the gain is not actually infinite. This causes a small error between the input pin voltages.
The output is passed through another filter to filter out any more DC components (harmful to speaker) and played through the speaker.

2) **The LM386 IC**: The LM386 is a low-voltage audio power amplifier, that can be powered with a battery. It has a default gain of 20, but can be increased up to 200 using resistors and capacitors between the gain PINs (1 and 8). We have left the gain at 20 as it was sufficient for the circuit demonstration.

VI. Observations

A common audio jack was used as input into both the circuits simultaneously. This allows us to hear the music and see the output on the LED array simultaneously. The volume of the output can be adjusted by turning the knob on the potentiometer.

The amplified audio was played through the speaker. For normal audio levels, the green and yellow LED rows were glowing prominently according to the variations in the audio signal. When the input audio volume was increased, or when there was a spike in the volume in the audio itself, the red LED rows started glowing momentarily.

The circuit is designed such that the green LEDs glow at low-intensity sounds, the yellow LEDs at medium-intensity sounds and the red LEDs at high-intensity sounds. The circuit worked as intended.

Voltage across the LEDs $\approx$ 2V (measured)
When input voltage to the audio-amplifier was 8V and the audio was a sinusoid of 528 Hz:

$$\begin{aligned} V_i &= 0.055V \quad \text{(between PIN 3 and ground)} \\ V_o &= 1.113V \quad \text{(between PIN 5 and ground)} \\ \implies \text{Gain} \quad A &= \frac{V_o}{V_i} = \frac{1.113}{0.055} \approx 20.23 \end{aligned}$$

which is close to the ideal gain of 20.

VII. Results

When the appropriate inputs were given to the circuit, it worked as expected. The LEDs glowed according to the sound intensity as intended. This concept can be extended to applications of VU meters in multiple domains such as audio processing, sound recording studios, radio stations etc.