Audio Spectrum Analyzer

Team Members

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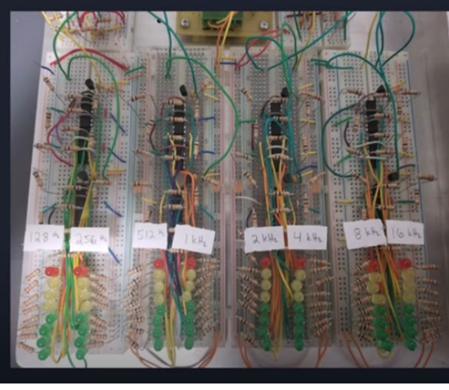
Introduction

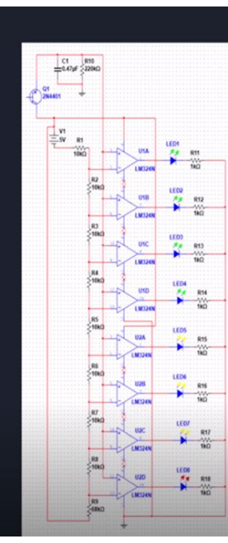
Our Project:

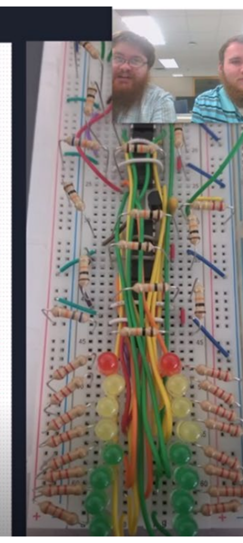
- Audio Spectrum Analyzer ("Visualizer")
- Measures the magnitude of an input audio signal
  - Ours is electrical, some use acoustic pressure or even optical
- Use in industry by audio engineers to measure their work
  - Shows volume level of frequency bands, allows for visual feedback
- Ours is a simplified version
  - Educational and entertainment



LED Display

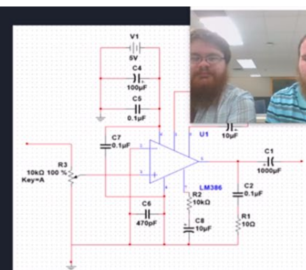
- 8 x 8 LED matrix with colors representing magnitude of signal
- Transistor circuit boosts signal a bit more to drive LEDs
- LM324N chip used
  - Quad Op-Amp package
  - Popular general use chip, useful for our project
- Voltage divider circuit
  - Bottom green LEDs require less voltage to turn on compared to top red

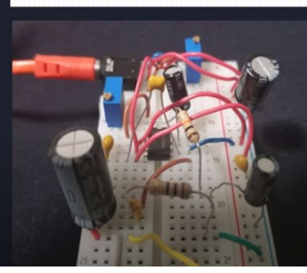




Amplifier

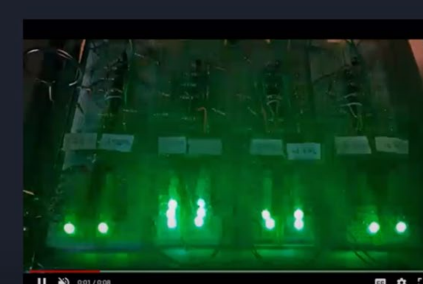
- LM386 - general low voltage audio amp
  - Max gain of 200
- Upgraded circuit from original design
- Most important part
  - Maintain signal clarity to filters for accurate reading
- Capacitors are added to the power rail
  - Filter low and high frequency noise
- 0.1 uF capacitor added for extra decoupling to the chip
- 10k and 10uF capacitor added to decouple the input signal
- Adds a 470 pF capacitor to filter radio interference





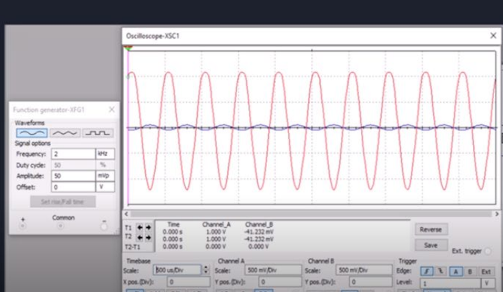
Final Project

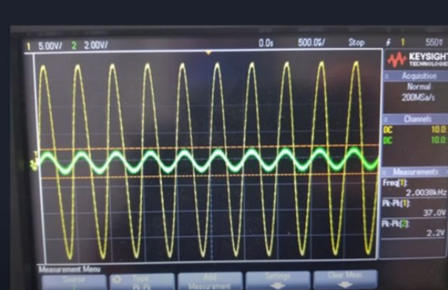
- Completed on breadboards
- Signal flows from audio amplifier to bandpass filters to the LED display
- Amplifier increases input signal voltage
- Filters clip frequencies that are above and below desired frequency
- Display turns on LEDs according to output band pass signal
- "Dances" as music is applied



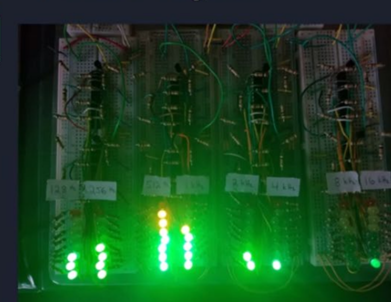
Amplifier Cont.

- Multisim simulation vs. Actual measurement

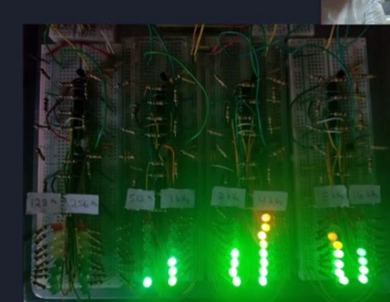




Final Project



- 500 Hz tone input



- 4 kHz tone input

Filters

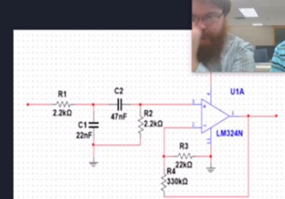
- 8 active wide bandpass filters were used
  - Low "Q" factor
  - 128 Hz - 16 kHz
- Low pass and high pass filters cascaded together to filter desired frequency
- Op amp provides extra voltage gain and isolation to the circuit
- Equations:

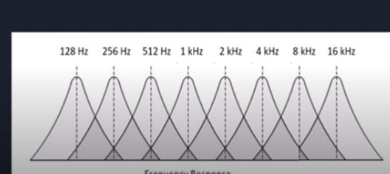
$$f_{upper} = 1 / (2\pi R_1 C_1)$$

$$f_{lower} = 1 / (2\pi R_2 C_2)$$

$$f_{center} = \sqrt{f_{upper} * f_{lower}}$$

$$BW = f_{upper} - f_{lower}$$





Possible Improvements

- Automatic gain / volume control for input
  - Won't have to adjust each time
- More filters could be used with higher quality and narrower bandwidth
- More LEDs could be added to each band for more precise magnitude measurement

Conclusion

- Final project works as intended
- Completed 95% of objectives
  - Decreased overall size from 10 x 10 to 8 x 8
- Happy with the results
- Building on breadboards turned out to be positive
  - Will continue to work on in the future