Iowa State University

ECpE

Senior Design Project
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Frequency Response Measurement System for at Home Laboratory Work

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Project Statement:

Throughout the COVID19 pandemic, students were left with limited access to lab benches while taking heavy lab classes. Iowa State University figured out how to send the students take home exploration boards. The problem was that these boards cost way too much money. On top of that the boards were sold out as many other programs attempted to buy the same boards. Our project has the goal of giving students the hardware to measure the frequency response of their circuits for a price that is reasonable.

Technical Requirements:

- Sweepable AC source with frequency ranging from 10 Hz to 1 MHz
- a chip to measure RMS voltages
- a microcontroller to automate the sweep and measurement
- a memory module for storing the measured results
- an interface for that can be used with a computer to control measurements
- Interface to receive and present data
- USB powered

System Design:

- RMS voltage measurement module will consist of a AD8436 that has an input voltage range of 100uVrms to 3Vrms.
- Frequency generator module consists of AD9833 that can generate a signal from 1Hz to 1MHz with sinusoidal, triangle, and square waveforms.
- The measurement modules is interfaced using SPI to an Arduino MCU.
- The MCU serializes to a PC for a user interface.
- Switch is used to change waveforms of function generator on the board.
- Serialized magnitudes are read by the Frequency Analyzer Application and saved into a CSV that can be exported by the user or displayed in an interactive plot.

Non-Functional Requirements:

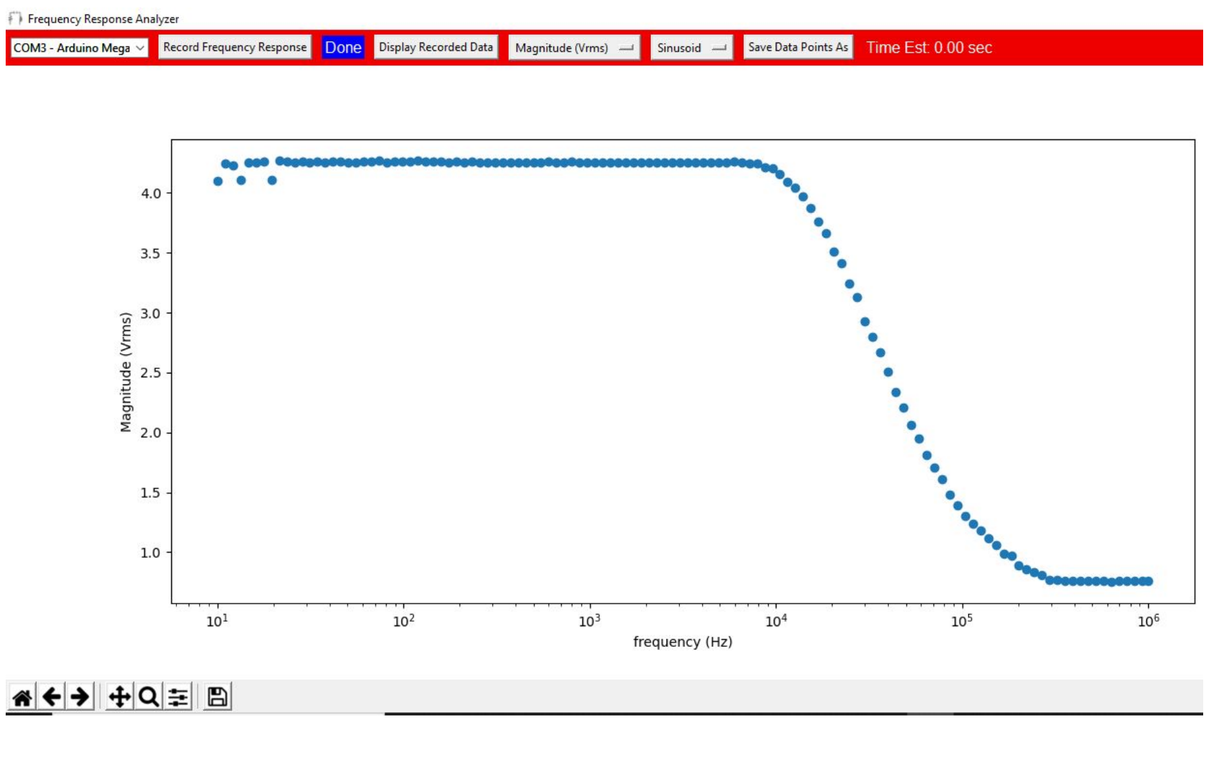
- Price tag of under $25 per unit
- Durable
- Portable
- Easy to use

Operating Environment:

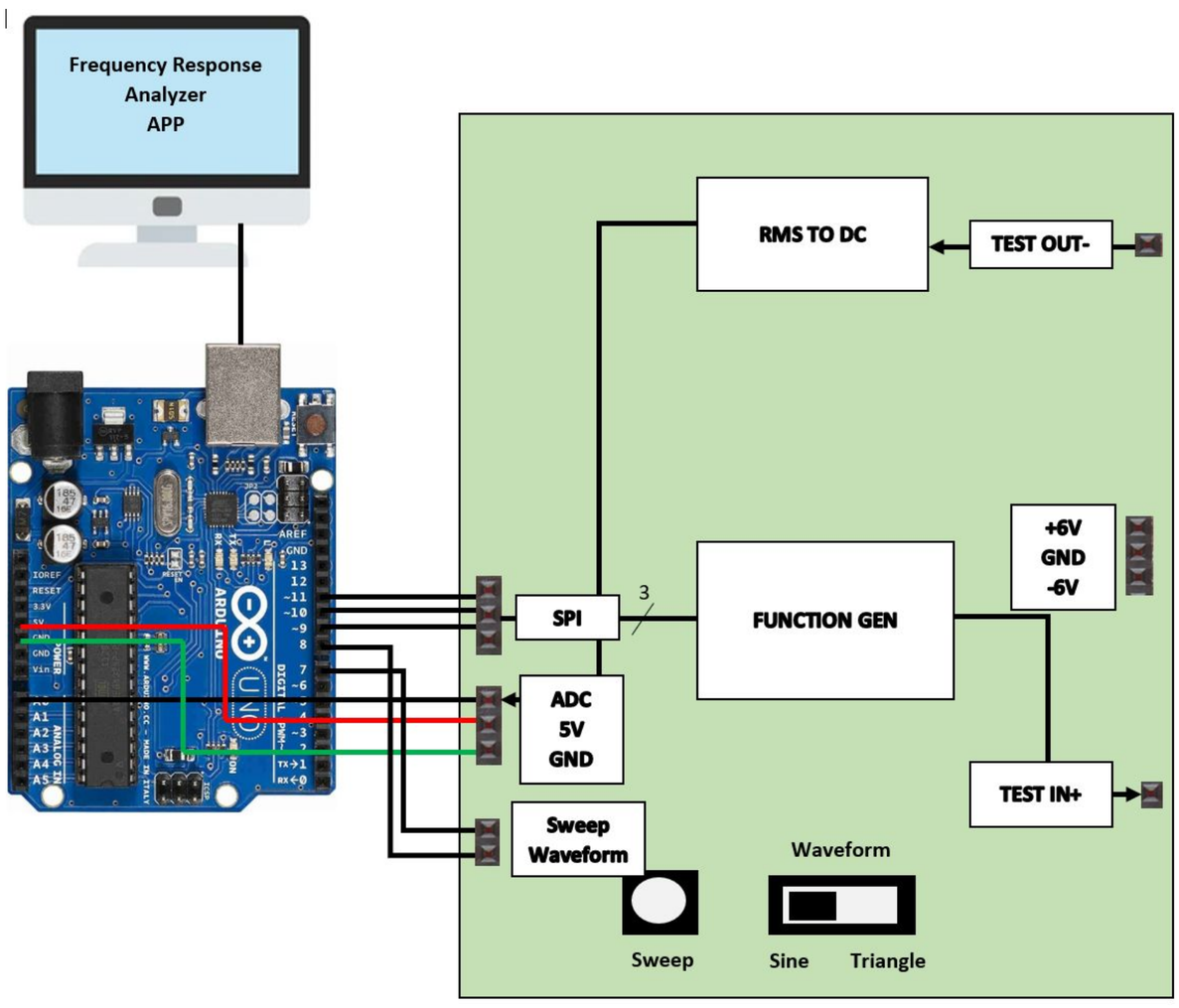
- Product is designed to be used by Electrical and Electronics engineers
- Product could be frequently used by students taking EE201, EE230, and EE333 at Iowa State
- Product is designed to be durable for the purpose of portability so that any place can be a temporary lab.

Testing:

- ADC was tested in lab and was within 5%
- Frequency generator was tested in lab to within 5%
- Software testing was done via unit testing. Testing was successful and an example plot is below



Block Diagram:



Technical Details:

- Arduino interface with built in MCU: ATmega328P
- RMS to DC converter: AD8436
- Function Generator: AD9833
- Software details:
  - Frequency Response Analyzer App (Python): tkinter, datetime, threading, shutil, os, time, math, matpotlib, csv, and pyserial.
  - Arduino Code (C++): <math.h> and <stdint.h>.

Engineering Standards:

Software:

- Unit Testing IEEE730

Hardware:

- IEEE754: Measurements must be accurate to two decimal places
- IEEE33-1927: Frequency specification must be accurate to 1Hz