Design and Construction of a Miniature Flow-through Conductivity Detector

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INTRODUCTION

- Pure water is a poor conductor of electricity however, dissolved ions present in water can carry an electric current. This property of ions can be used to detect water purity by measuring the water's conductivity (the ability to conduct electricity) when testing for ionic impurities.
- Our lab aims to produce Conductivity Water (water with 18 MΩ cm resitivity) on a nL/min scale. To detect the purity of water on such scale, in this project, we attempt to design and construct a Miniature Flow-through Conductivity Detector.

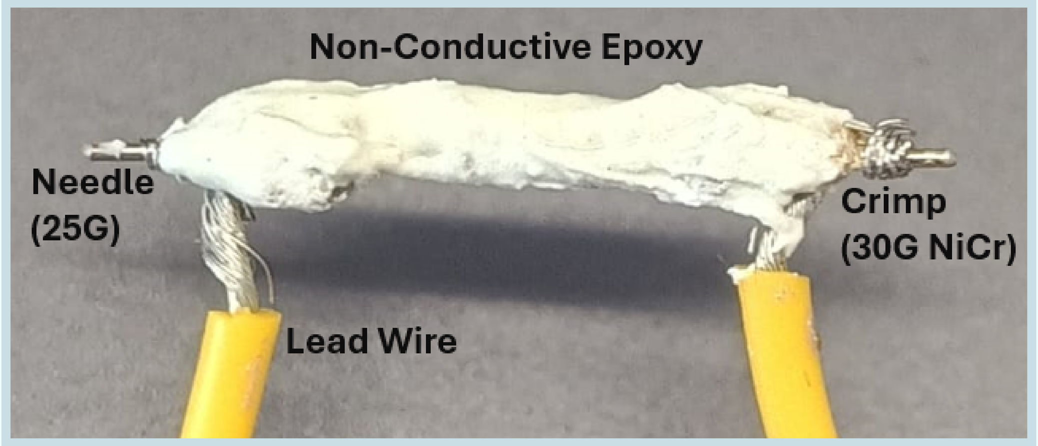

Figure 1. Image of a Conductivity Detector Flow Cell

SCHEMA

Conductivity Detector Cell

- A pair of 25G hypodermic stainless steel needles were electropolished in 2% HNO_3 to flatten ends.
- The needles were placed barely touching (20 µm) inside a 26G PTFE about an 2.5 cm in length.
- The body of the needle outside the tube was soldered to a lead wire for electrical contact.
- The connection between the needle and the wire was then covered with conductive silver epoxy resin. The body was covered with non-conductive resin.

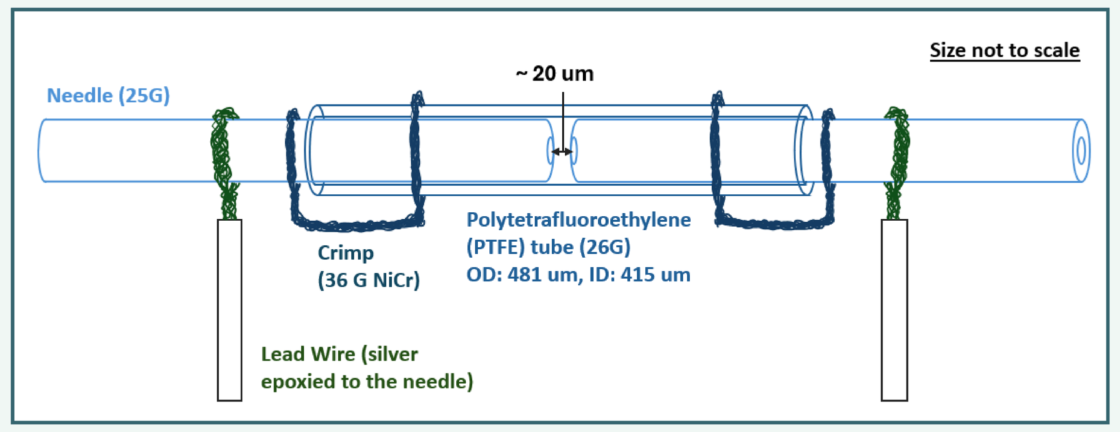

Figure 2. Schematic diagram of a Conductivity Detector Cell

Full-wave Rectifier

- The datasheet for P/N TL082 was referenced to determine the accurate placement of components on the breadboard.
- The components were then placed and examined for errors. Once verified, they were then soldered to the breadboard with a soldering wire made of Tin alloy.

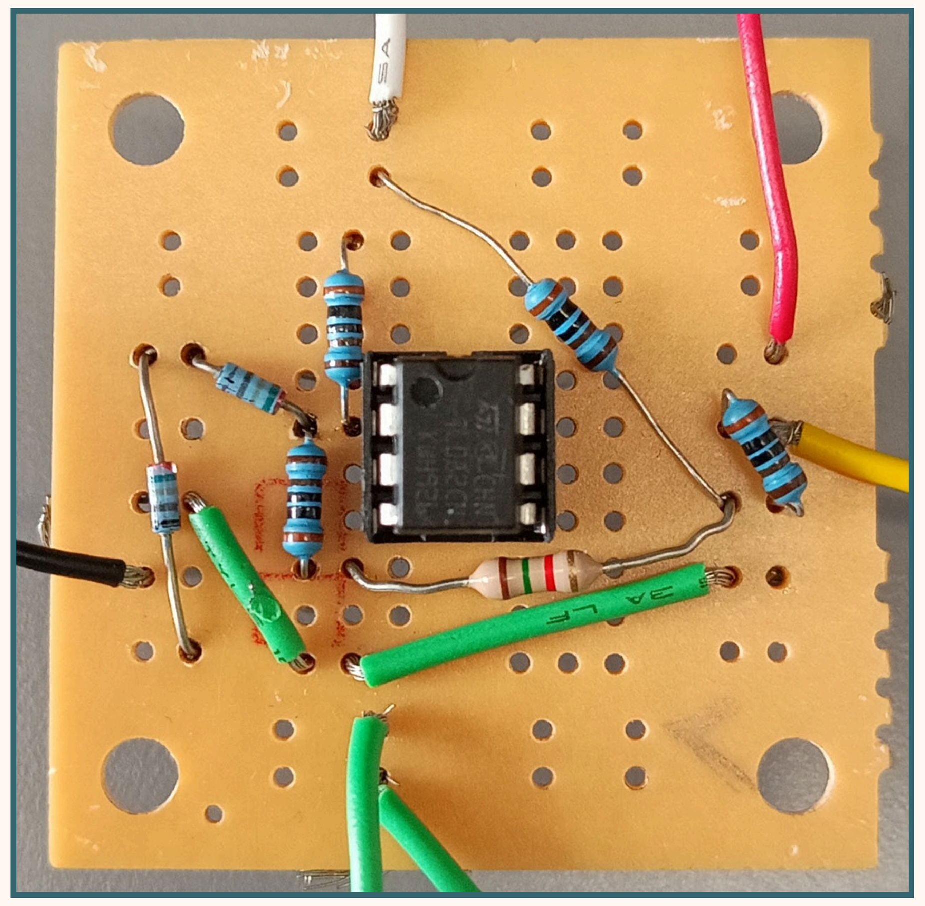

Figure 3. Image of a Full-Wave Rectifier

Square-wave Generator

- The above process was applied to construct the Square-wave Generator as well while referencing the datasheet for P/N NE555N.

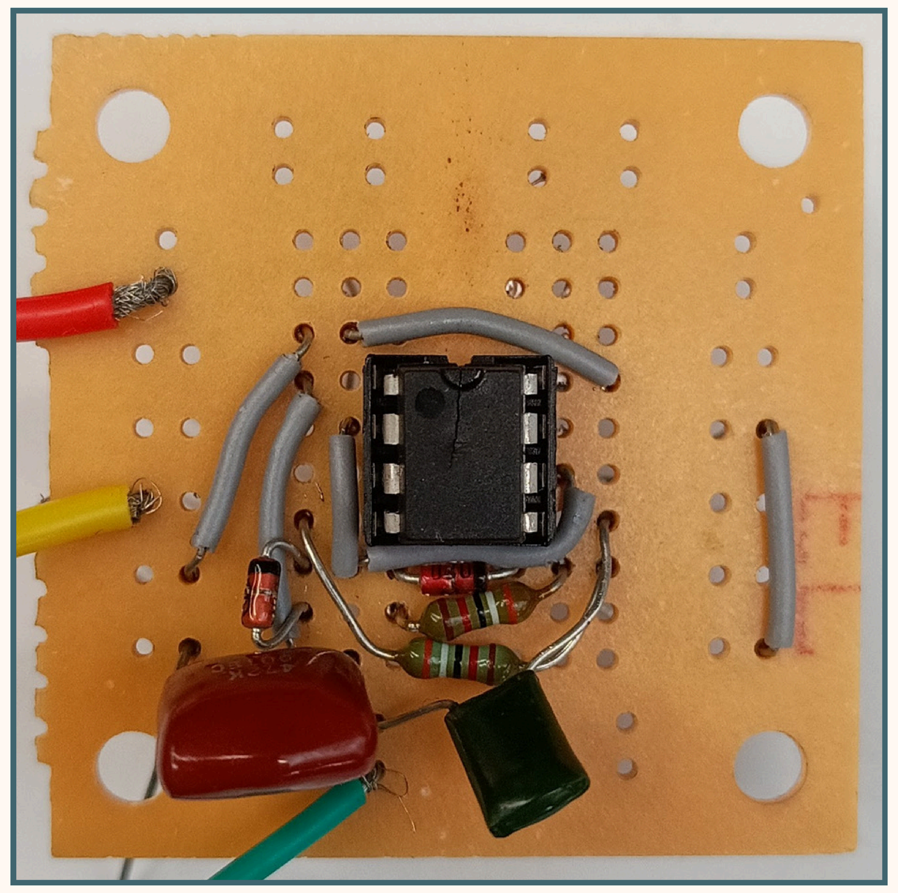

Figure 4. Image of a Square-wave Generator

RESULTS

Calibration of Conductivity Detector Cell:

- The blank conductance (DI water run through the cell) was 155 nS.
- The conductance when 1 mM KCl was run through the cell at the same speed was 1.04 µS.
- Measured conductance was calculated (1.04 - 0.155 µS) to be 0.89 µS.
- Finally, the cell constant (standard conductance of 1 mM KCl (147 µS) /measured conductance) was found to be 170 per cm.

Calibration of the Full-wave Rectifier:

- Following measurements for DC output was taken for each AC input (V, rms).

AC	DC	AC	DC	AC	DC	AC	DC
0.69	0.64	2.25	2.10	4.25	3.96	6.25	5.83
0.75	0.70	2.50	2.33	4.50	4.20	6.50	6.06
0.85	0.79	2.75	2.56	4.75	4.43	6.75	6.35
1.00	0.93	3.00	2.80	5.00	4.66	7.00	6.58
1.25	1.16	3.25	3.03	5.25	4.89	7.25	6.77
1.50	1.40	3.50	3.26	5.50	5.13	7.50	6.94
1.75	1.63	3.75	3.49	5.75	5.36		
2.00	1.86	4.00	3.73	6.00	5.60		

Figure 5. AC and DC value table

- These values were plotted as DC output vs AC input to give the graph below.

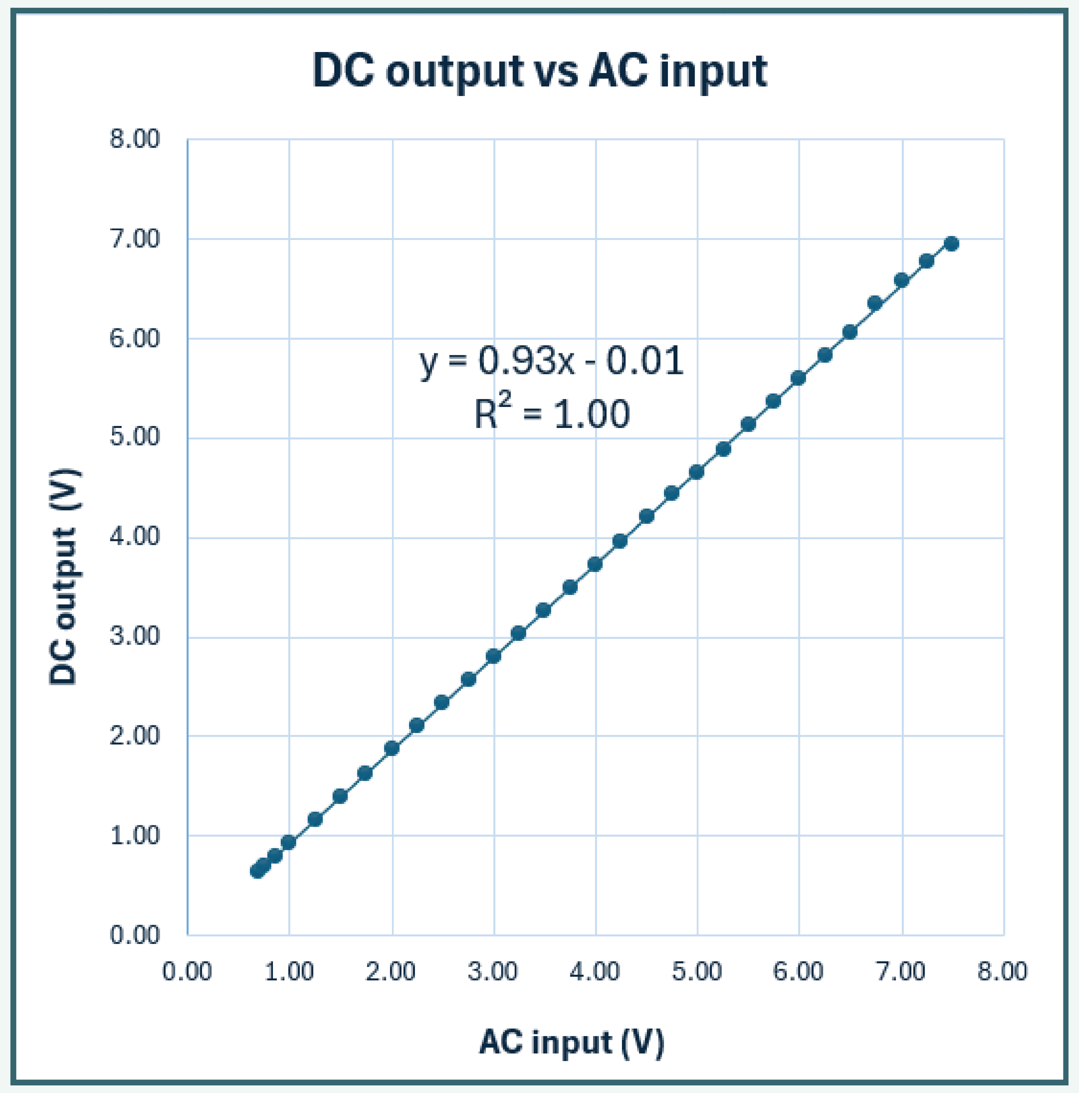

Figure 6. DC output vs AC input

Results for Square-wave Generator

- Oscilloscope displayed approximately a 70% duty cycle wave.
- Duty cycle can be controlled by different combinations of resistors and capacitors to get 50% duty cycle, which is desired to avoid polarization in the flow cell.

Figure 7. Image of an Oscilloscope display connected to Square-wave Generator

CONCLUDING REMARKS

- A square-wave generator with roughly 70% duty cycle was built. The next step is to change the duty cycle to 50% (to avoid polarization of the electrodes of flow-through cell).
- A flow cell was successfully constructed to measure the conductivity of water on a nL/min scale. It was found to have a cell constant of 166 per cm.
- A rectifier for the Data Acquisition System, which requires a DC input, was designed and assembled.
- Next step is putting together above elements with a digital panel meter for display, and power input cord and analog output terminals (to be connected to an external data recorder) in a project box

ACKNOWLEDGEMENTS

I thank Dr. Dasgupta for his guidance throughout this research. I also appreciate Chandan Chaudhary for his assistance with methodology and implementation. Finally, I thank The Office of Undergrauate Research for their financial support, which enabled this study.

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