Charge Measurement Device

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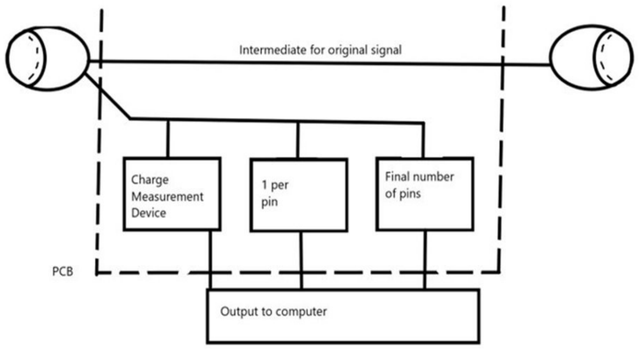
Problem Statement

Honeywell needs a way to accurately measure the accumulation of charge on electronic devices. The desired device should be small and capable of handling at operating points that Honeywell specifies. The application of this device is important for extending Honeywell's ability to understand the behavior of their electronics.

Conceptual Sketch



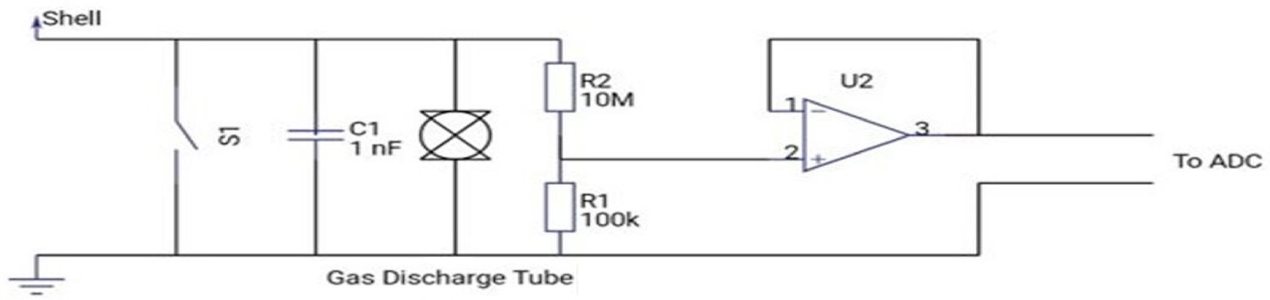
Functional Requirements

- Capable of operating at 250-750 V
- Accurately measure charge accumulation from 10-300 nC
- Restricted to DC operation
- UI compatibility

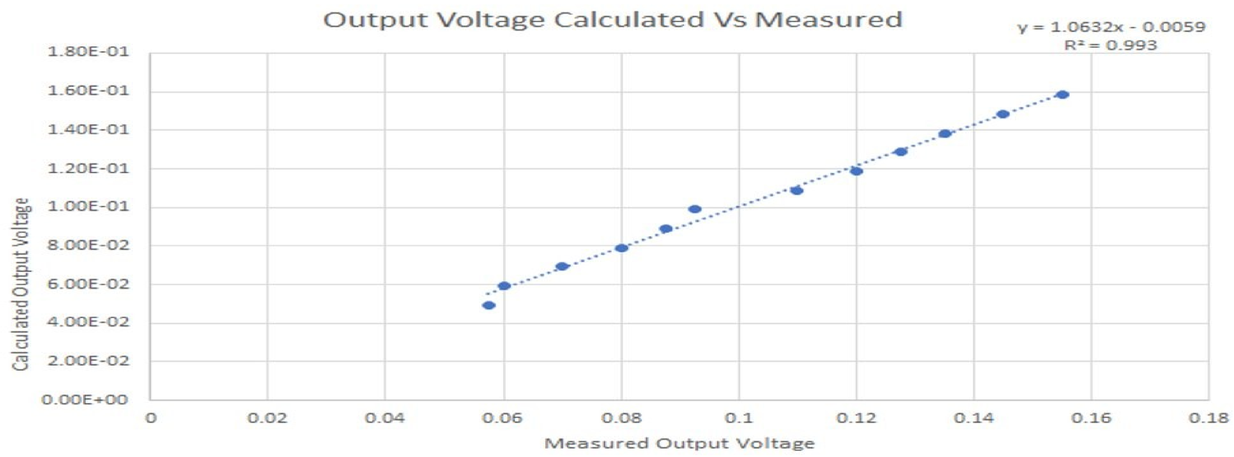
Non-Functional Requirements

- Easily duplicated/simple design
- Relatively small PCB (around 3"x6") and final product enclosure
- Enclosure should protect the user from the high voltage
- Remain within budget restrictions ($2500 per semester)
- Lab based equipment
- Cost is not an issue
- Users are knowledgeable about the design

Circuit Design

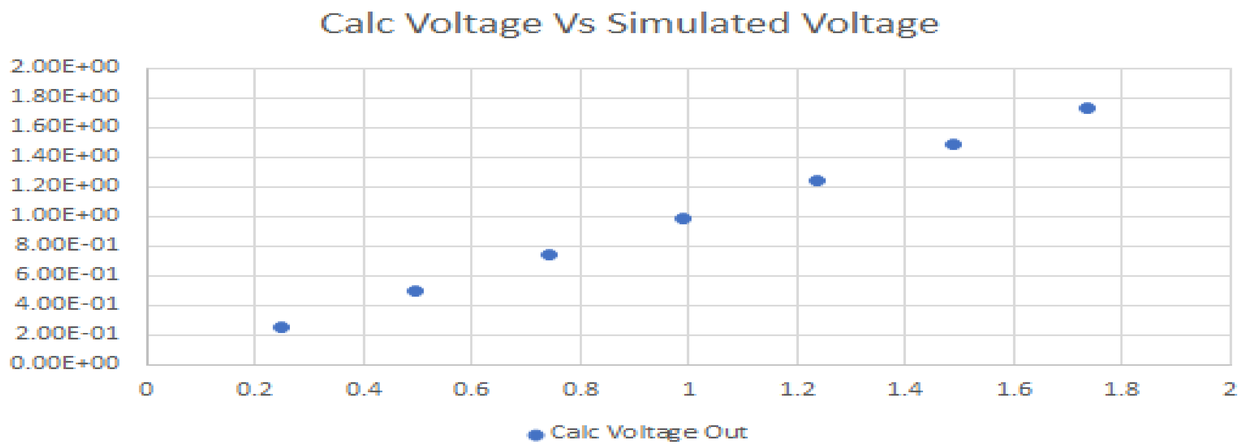


Low Voltage Testing



Testing yielded the linear relationship we predicted. The correlation between calculated and measured is $R^2 = 0.993$

PSPICE Simulation (High Voltage)



Simulation yielded the same linear relationship from the low voltage model. The correlation isn't as relevant due to ideal testing conditions

Solution Approach

Our team began exploring potential solutions through both research of new information and recollection of relevant material from previous courses taken at ISU. We have created a process flow to be referenced throughout the duration of the project. This helped everyone to stay organized and in sync with the current state of the design. An Agile-based process also proved to be of use for organization and execution of all tasks.

Engineering Standards & Practices

IEEE 4-2013 (High Voltage Testing)
IEEE 1696-2013 (High Voltage Probe Measurement)
No official design practices were applied to this project. The main design constraint this project dealt with was ensuring that all components and systems would safely operate under the high voltage range designated by Honeywell.

Testing Strategy

To simplify our testing procedure, we decided to not use an ADC and measure the direct output voltage of the buffer. We used both an oscilloscope and multimeter to measure the output voltage. A DC power supply is used to charge a separate static capacitor. At t=0, a switch is flipped to disconnect the power supply and connect the capacitor to the shell. We would sweep the charge voltage and record the results of the output. These measurements would then be compared to the calculated voltage.