Practical PCB Design and Manufacture

Lab-26 Report: ESD measurement and mitigation

Objective / Purpose of the Lab:

This lab aims to explore the generation, detection, and impact of electrostatic discharge (ESD) using an Arduino-based static field detector. Participants will engage in hands-on activities to understand how everyday interactions between insulators can generate static charges and induce large electric fields, posing risks to sensitive electronic components.

Some of the Activities and Learning Outcomes are as follows:

1. Measure static electric fields generated by various materials.
2. Analyse the effects of grounding on reducing ESD damage.
3. Develop preventive strategies to safeguard electronics against ESD risks.

Component Listing:

- Arduino UNO
- Single piece of wire

Board Connections:

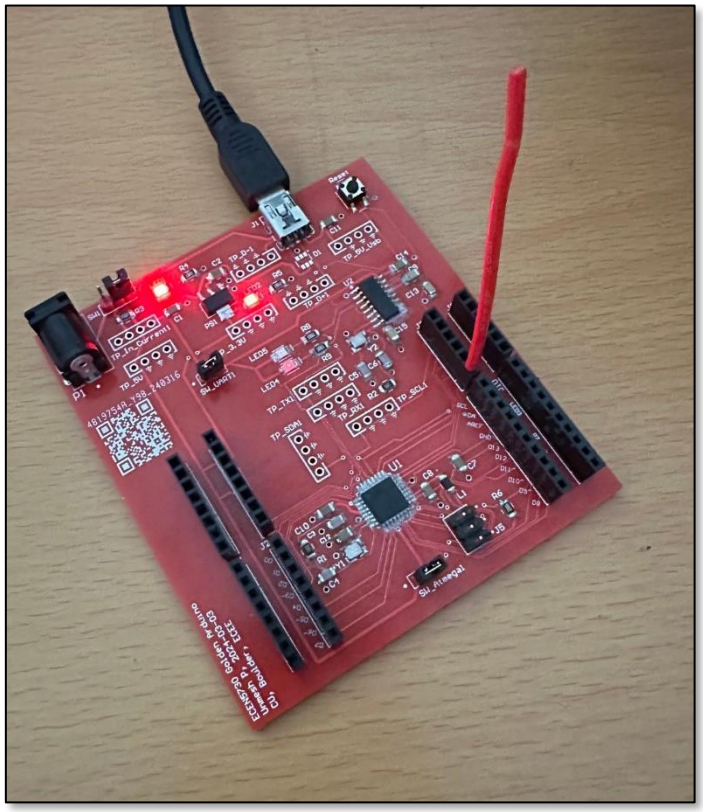

Fig – 1: Board Connections

Code Implemented:

Code 1:

```
#include <avdweb_AnalogReadFast.h>
void setup()
{
  Serial.begin(1000000);
}

void loop()
{
  Serial.print(analogReadFast(A0)); Serial.print(", ");
  Serial.print(0); Serial.print(", ");
  Serial.print(200);
  Serial.println();
}
```

Code 2:

```
#include <avdweb_AnalogReadFast.h>

// Measure static electric fields for n PLC
int pinADC = A0;
int nPLC = 1;
long iTime2Average_usec = (1000000.0 * nPLC ) / 60.0; // time we want to average
float V_ADU;
long nCountsActual;// number of actual measurements averaged
long iTimeStart_usec; // start of averaging time
long iTime2Stop_usec; // stop of averaging time
////////////////////////////////////////////////
void setup()
{
  Serial.begin(1000000);
  /// this routine will get the input to the ADC into a steady state value
  for (int i = 1; i < 3000; i++)
  {
    V_ADU = analogRead(pinADC);
  }
}

void loop()
{
  ////initialize variables at start of loop///
  V_ADU = 0.0;
  nCountsActual = 0;
  iTimeStart_usec = micros();
  iTime2Stop_usec = iTimeStart_usec + iTime2Average_usec;
```

```
  ////////////////////////////////////////////
  while (micros() < iTime2Stop_usec)
  {
    V_ADU = V_ADU + analogReadFast(pinADC) * 1.0;
    nCountsActual++;
  }
  V_ADU = V_ADU / nCountsActual;
  //Serial.print(nCountsActual); Serial.print(", ");
  Serial.print(V_ADU);
  Serial.println();
  ////plot with fixed scales
  Serial.print(V_ADU); Serial.print(", ");
  Serial.print(0); Serial.print(", ");
  Serial.print(200);
  Serial.println();
}
```

Serial Monitor Output:

For Code 1, we the following output on the serial plotter:

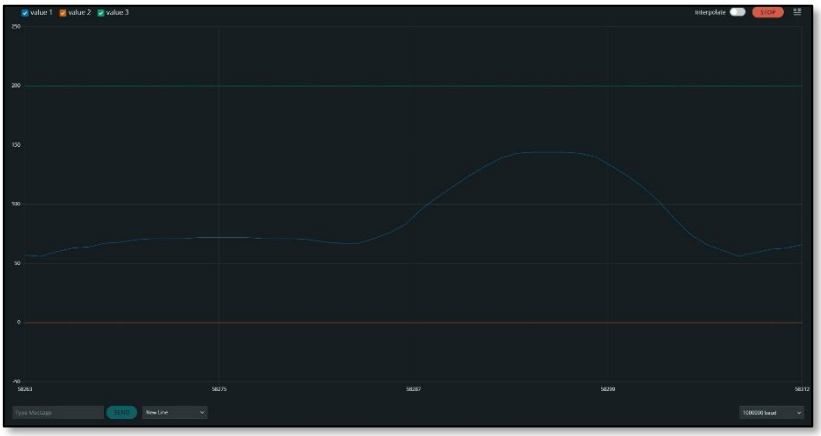

Fig – 2: No interference

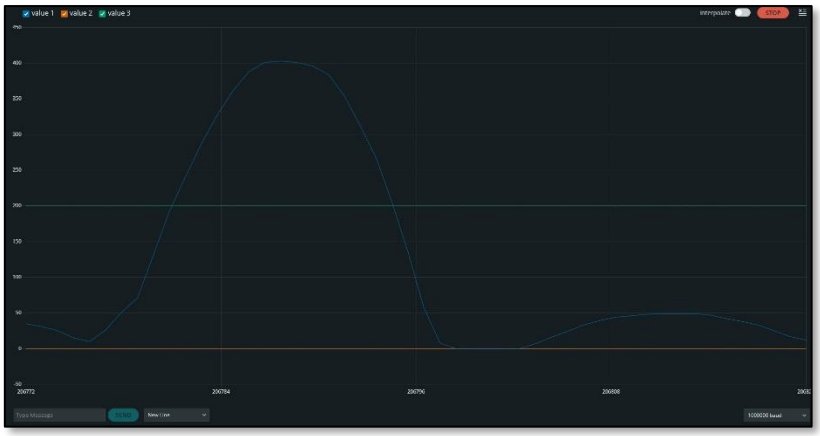

Fig – 3: With Static interference

To reduce the noise, we use the 2nd code. This code significantly enhances data accuracy and stability compared to the first by implementing several key improvements. It averages multiple analog readings within a defined time frame, effectively reducing noise and fluctuations that could affect the data's reliability. This averaging process is particularly crucial for applications requiring precise measurements. The code initializes the analog-to-digital converter (ADC) by repeatedly reading the ADC input before the main loop starts, ensuring that the readings stabilize and reach a steady state. This "warm-up" phase enhances the consistency and reliability of subsequent data collection. Additionally, the code incorporates precise timing controls to manage sampling intervals accurately, ensuring that readings are consistently taken over the intended duration. It also calculates the actual number of samples collected, allowing for accurate normalization of the data. These features make the second code highly effective for demanding applications, such as detailed data logging or precise scientific measurements, where data integrity is paramount.

After successful noise reduction, we get the following plot on the serial plotter.

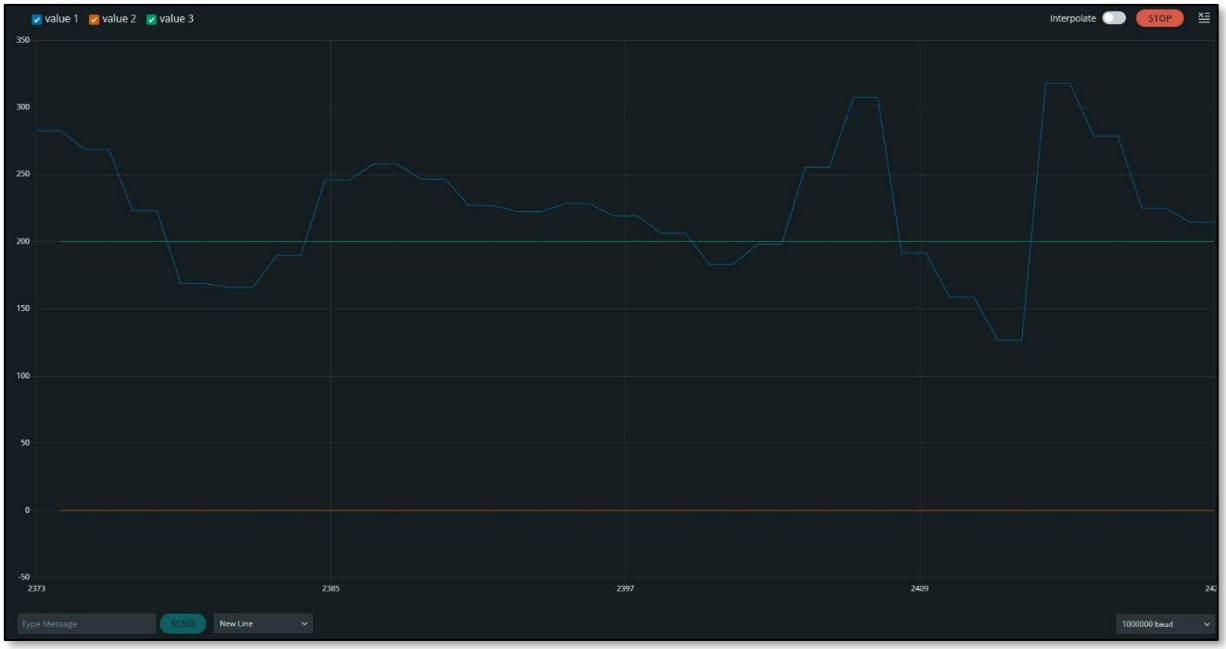

Fig – 3: With Noise Reduction

Conclusion / Inference:

- Experiments show that actions like rubbing hands on clothes or sliding on a chair can significantly increase a person's static charge, illustrating everyday activities' impact on static electricity.
- Touching an earth-grounded surface effectively reduces static charge quickly, indicating that continuous connection is unnecessary for effective static dissipation.
- The use of a low-cost Arduino-based static E-field meter demonstrates its utility as an educational and practical tool, enabling simple yet insightful experiments that are accessible and informative for those unfamiliar with electronics.