# Radio Telescope

**EE 396**
**Design Laboratory**

**Prajkt Sonkusare : 210108034**
**V. Samuel Cripps : 210108060**

*Under the supervision of*
**Prof. Hanumant Singh Shekhawat**

**EEE Department**
**Indian Institute of Technology, Guwahati**
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# 1 Introduction

## 1.1 Background

A Big Telescope is required to detect radio waves from astronomical sources and due to their long wavelengths, large radio telescopes are needed to gather signal and achieve resolutions comparable to optical telescopes. Building large telescopes is mechanically and economically challenging. Several schools, colleges and community astronomy clubs have optical telescopes, however, radio telescopes are not as famous due to their cost, the size and complexity of the data.

## 1.2 Motivation

We have developed an affordable, portable college level radio telescope for amateur radio astronomy which can be used to provide hands-on experience with the fundamentals of a radio telescope and an insight into the realm of radio astronomy.

## 1.3 Objectives

Our goal is to use the satellite finder to record the sun's radiation intensity during a solar transit and thus possibly be able to distinguish a quiet sun from an active sun based on the recorded amplitude.

## 1.4 Instruments Required

- A Satellite Dish
- A LNB (Low Noise Block)
- Coaxial Cable
- Rg6 Connectors
- A 12V battery
- A Satellite Finder
- An ADS1115 analog to digital convertor
- An Arduino (Nano)
- ALM7809 IC (Voltage Regulator)
- Capacitors (10 µF and 100 nF)
- An LCD (optional)

# 2 Set-up

## 2.1 Block Diagram

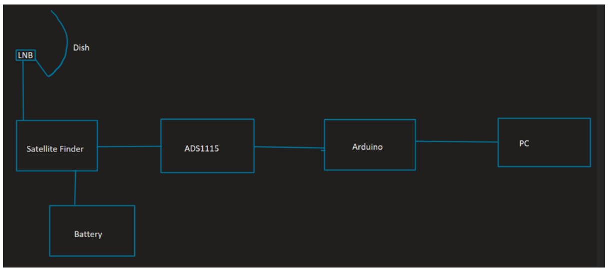


Figure 1: Schematic of Radio Telescope

### 2.1.1 Circuit Diagram

### 2.1.2 Reason behind using these components

#### 2.1.2.1 LM7809

LM7809 work as voltage regulator, and to operate Arduino Nano voltage range of 7-12 Volts is required, so to maintain constant voltage of around 9V we are using LM7809.

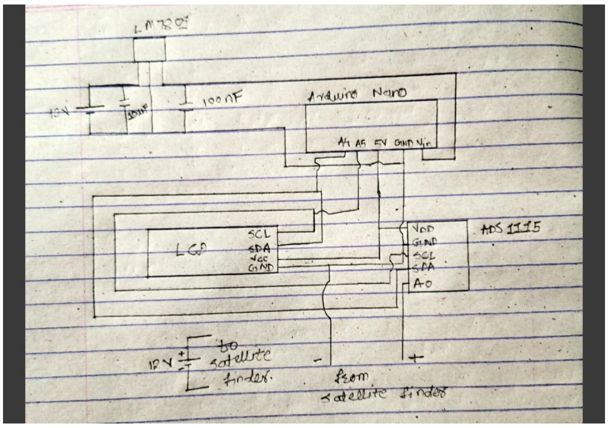


Figure 2: Connection Diagram

#### 2.1.2.2 ADS1115

The voltage measured directly of satellite finder using multimeter and found out to be in range of 0-300mV, since this voltage is very small for Arduino to detect so, we used analog to digital convertor ADS1115 which can detect 0.000076V(76 µV) i.e., 5/65536, and set its gain to 8.

#### 2.1.2.3 How did we made the connections of Satellite Finder to ADS1115

We opened the Satellite finder and soldered two connections and took it out of satellite finder as shown

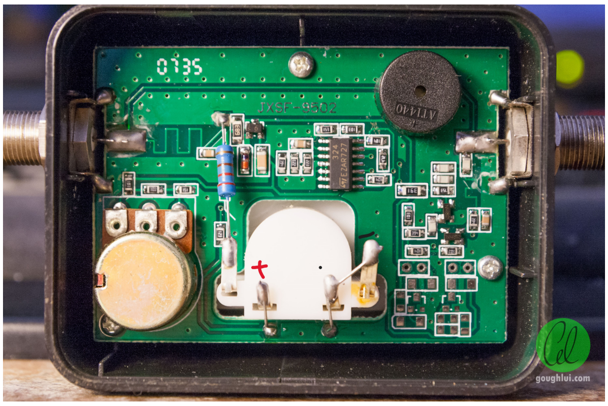

Figure 3: Satellite finder connection

#### 2.1.2.4 How did we made the connections of Satellite Finder to Battery

To supply the satellite finder with voltage, the 12V battery is connected to the coaxial cable as shown, i.e. GND to the shielding and the +12V to the core (inner conductor).

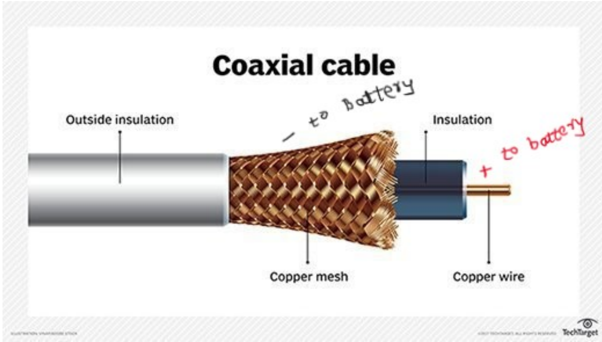


Figure 4: Satellite finder connection

# 3 Procedures

## 3.1 Ideal Drift Scan of Sun

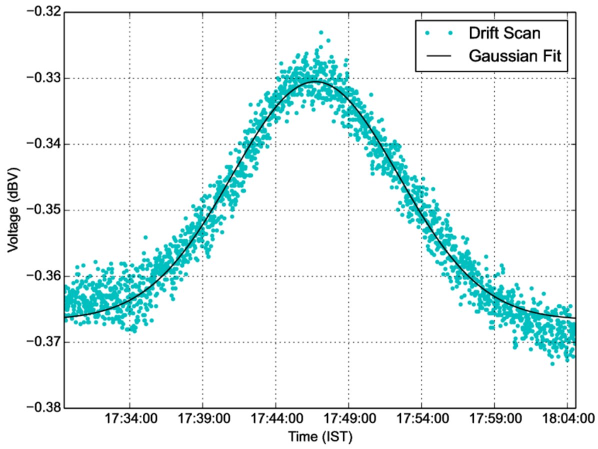


Figure 5: Drift Scan of Sky

Drift scan is a technique that uses the movement of stars to image long strips of the sky. The sun's movement can help you guess where it will go, always up or down, and right. You can do a half drift scan, which is safer and takes 15 minutes.

## 3.2

### 3.2.1 Output without using ADS1115

We recorded the measurement curve directly with the serial plotter of the Arduino IDE: As it was discussed earlier output voltage from satellite finder is very small and arduino can't sense it, as a result the graph would not be nice and smooth. Hence, we use ADS1115.

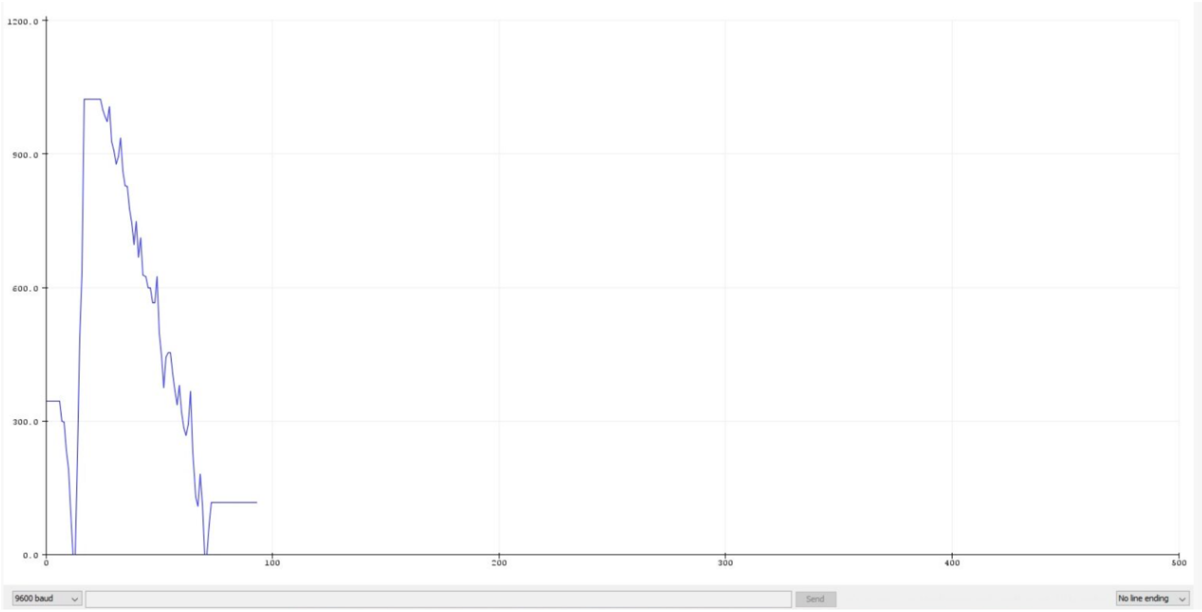


Figure 6: Curve without ADS1115

#### 3.2.2 After using ADS1115

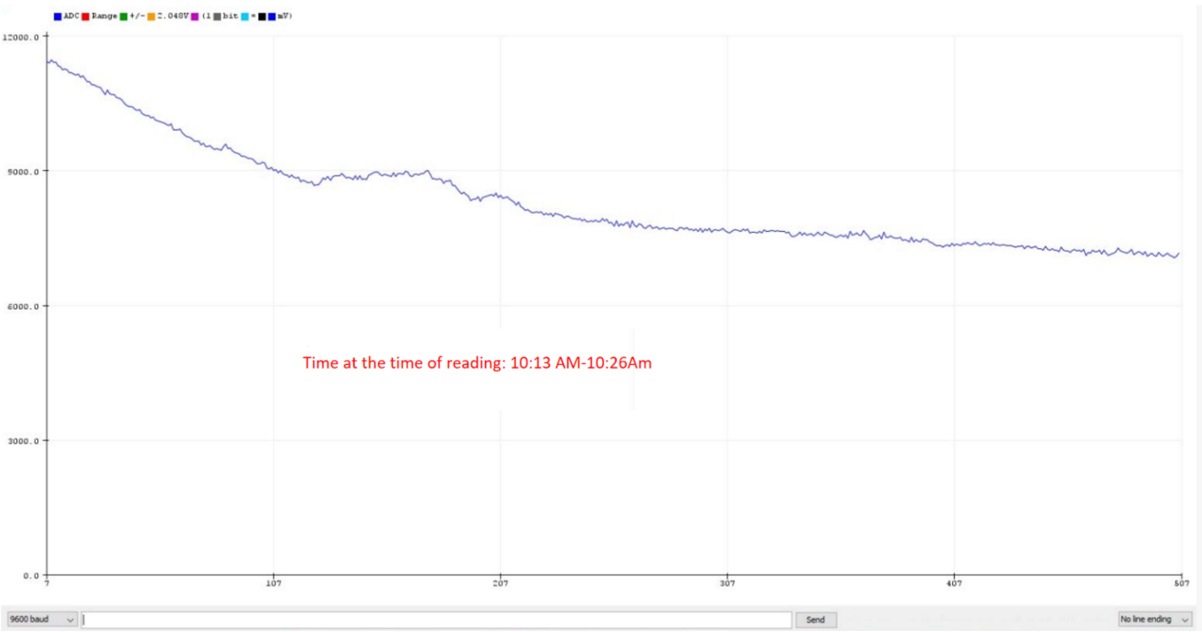


Figure 7: Curve with ADS1115

In the above curve we can see as the sun position is changing from time 10:13 AM-10:26AM , focus of dish from sun is also changing, hence sun's radiation intensity is decreasing so we are getting decreasing curve.

#### 3.2.3 Another reading

Now, if you observe the below curve its very similar to Figure 5.

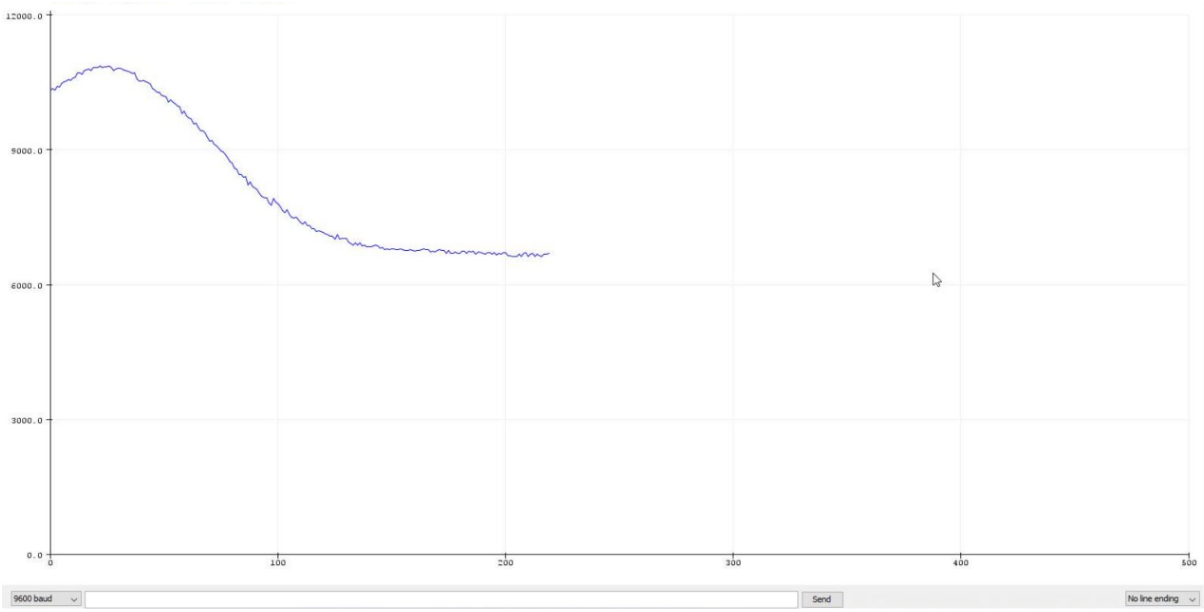


Figure 8: Curve with ADS1115

# 4 Calculations

## 4.1 Calculation of Field of View of Satellite Dish

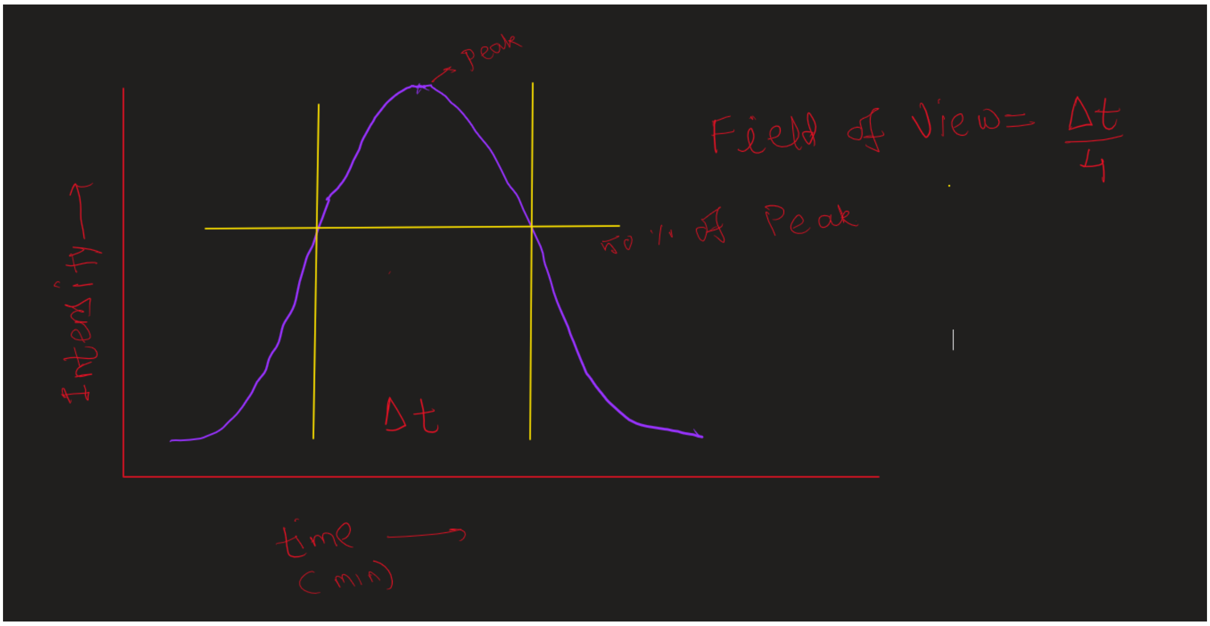


Figure 9: Concept of Field of View

For practical calculation of field of view, consider Figure 8, after observing 100 on x-axis and considering this point as 10 minute and accordingly, if we observe Figure 8 , we are getting Peak value on curve at approximately 3 minute and half of Peak at approximately 8 minute, so $\Delta$**t** = **5*2 minutes**

so, practical field of view will be **(5*2/4) degree** which is **2.5 degrees**, here we have multiplied by factor 2 because we are considering only half symmetric curve from figure 8.

Theoretically, The sun moves 1 degree of longitude every 4 minutes, because the Earth rotates 360 degrees in 24 hours, or 1 degree in 4 minutes. This means that the sun takes 4 minutes to move from one longitude to the next. So, theoretically in 10 minutes Field of View is **10/4 = 2.5 degrees**,Hence **Theoretical and Practical Values are Matching, it Means Radio Telescope is working Fine.**

## 4.2 Working Code

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <Adafruit_ADS1X15.h>
Adafruit_ADS1115 ads1115;

LiquidCrystal_I2C lcd(0x20, 16, 2);
void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  Serial.println("Reading");
  Serial.println("Getting single-ended readings from AIN0..3");
  Serial.println("ADC Range: +/- 2.048V (1 bit = 0.0625mV)");
  Wire.begin();

  lcd.init(); // initialize the lcd
    lcd.backlight(); // Turn on the Backlight
    ads1115.begin();// Initialize ads1115
    ads1115.setGain(GAIN_EIGHT);
    delay(4000);



}

void loop() {
  // put your main code here, to run repeatedly:
  int16_t adc0;
  adc0 = ads1115.readADC_SingleEnded(0); // reads input from Satellite finder
      through ADS1115
  //float adcV;
  //adcV = adc0*0.000015625;
  lcd.clear(); // Clear the display buffer
    lcd.setCursor(0, 0);

    lcd.print("Readings:"); // print "Distance:" at (0, 0)
    lcd.setCursor(0,1); // Set cursor for output value  (0, 1)

    lcd.print(adcV); // print Output in cm at (0, 1)
    Serial.println(adcV);
    delay(4000);



}
```

## 5 Conclusion

We have successfully conducted an experiment, and demonstrated 1 application of Radio Telescope, obviously there are many other applications which can be explored using this telescope, but considering affordability, this Telescope is good to go.