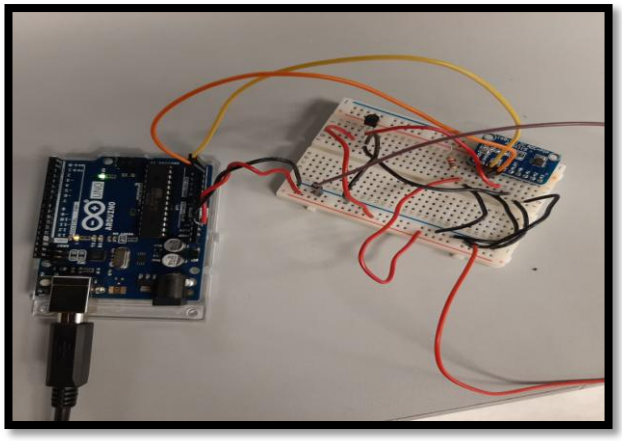
GOAL- Single Ended and differential measurements and I2C communications

In this experiment we measure the single ended measurements as well the differential measurements and compare both the signals for the temperature sensor.

At roughly 20 deg Celsius the voltage of the sensor is around 0.7 volts, these are the formulas being used in this experiment.

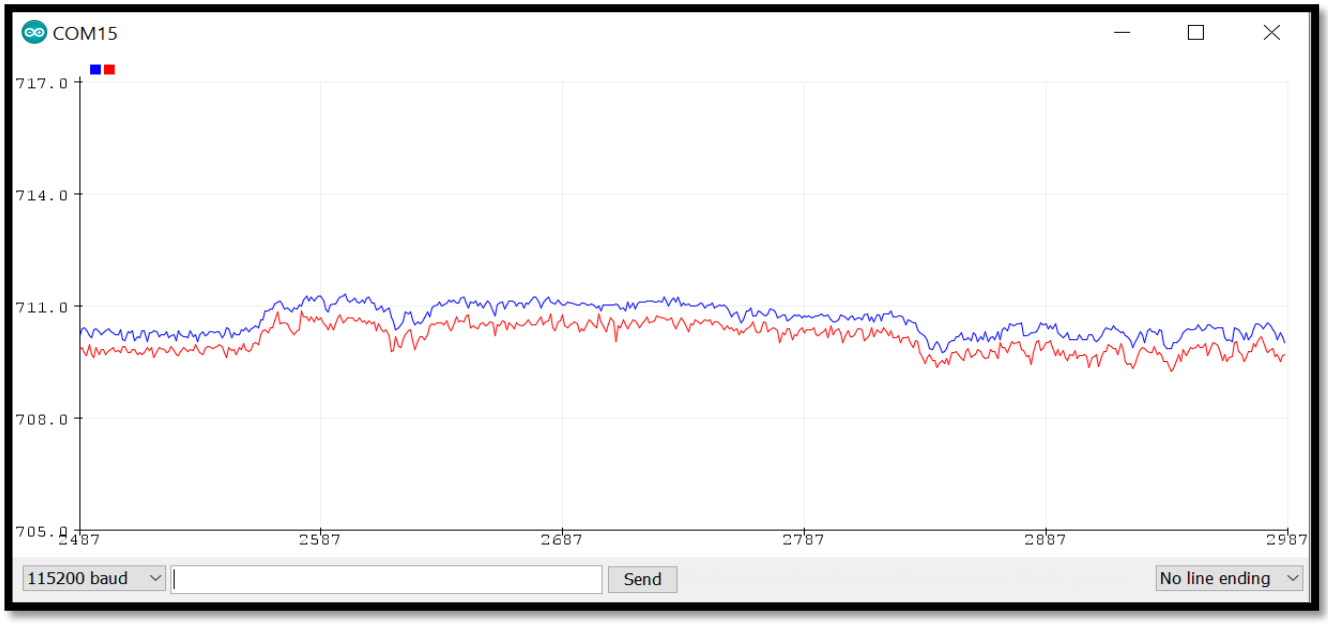
T[degC] = V[volts] x 100[degC/ V] −50 [degC]

V[Volts] = T[degC] x 0.01[Volts/degC] + 0.5[Volts]



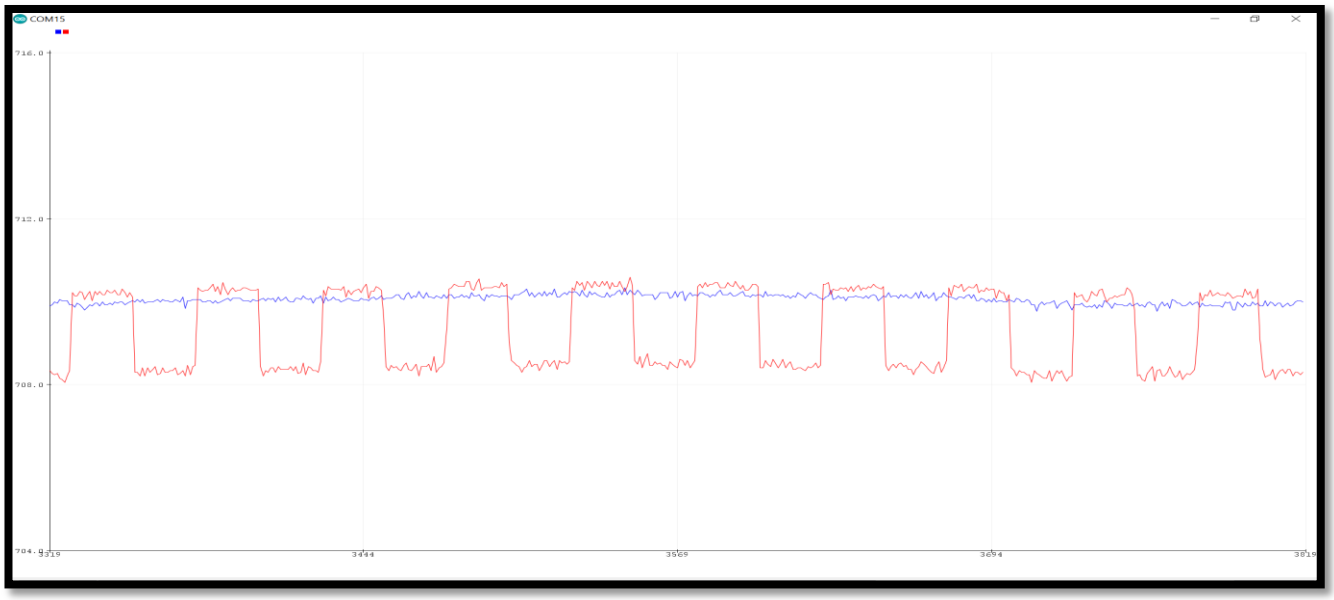
The temp sensor TMP36 is inserted far from the ADS1115 which helped us to add noise in the ground return path and get the difference between the differential and common signal measurement. For single ended signal the voltage between TMP36 and local ground of ADS1115 is measured. This voltage includes any voltage in the ground path from the local GND of the TMP36 pin and the local GND near the ADS1115 module. The connection for TMP36 and ADS1115 is done as per the convention and for differential we have routed the AIN0 to TMP36 output voltage pin and AIN1 to local GND of TMP36.

Next the libraries of ADX1115 were installed and the code was modified on the differential code, the gains to the PGA have been set to 4, and the output on the plotter was observed. In the serial plotter there was a slight difference between the voltage of the single ended and the differential ended output which signifies little voltage presence in the local ground.



Differential and single mode when no current was supplied as noise.

Later the noise was given using the function generator which was set at 1Hz frequency and 5 Volts amplitude. It was given on the ground plane of both the circuits. The differential circuit does not have the noise on the plotter but the single end will have the square wave on the plot as the noise signal.



Differential and single mode when current was supplied as noise on both the GND ends

- With no current in the ground connection between TMP36 and ADS1115 the temperature read by the TMP36 was around 22.1 degree Celsius.

According to 0.721 V the temperature will be- :

T[degC] = 0.721[volts] x 100[degC/ V] −50 [degC] = 22.1 degree Celsius.

- With no current in the ground path the voltage difference between the differential measurements and the single ended measurements of the TMP36 was around 0.02volts
- The current at the function generator in the ground return path was around 50mA.
- When there was a current flowing through the ground path the voltage difference between the single ended and differential ended based on the resistance of 0.04 ohms would be 2mV peak to peak.
- The recommended routing for the differential pair for the lowest noise pickup would be to route them over a continuous return path, routing the two lines as far away from other signal line as practical and finally routing the two lines as close together as possible so they share the common environment.

Without external pull up resistor

With external 1k pull up resistor

- Without using an external pull up resistor, if the capacitive load is much more than 30pf then the 40k internal pull up resistor will slow down the rising edge and the line may not come up in time which is why a lower pull up resistor value will be helpful to charge the line faster. Though it will have more power dissipated but it's a good trade-off between power consumption and fast enough charging. Hence with external pull up resistor of 1k the rise time decreases to 87.6 ns as compared to without external pull up resistor having rise time of 910ns.