JIBEBE PROJECT

ELCTRICAL TEAM

OBJECTIVES FOR THE ATTACHMENT

1. Testing the motor and battery
2. Development of the control system

SPECIFIC OBJECTIVES

1. Connecting the motor, controller and battery together.
2. Coming up with the high voltage and low voltage circuit
3. Integrating the display with the controller
4. Connecting the buck converter to the controller
5. Designing a 12v to 3.7v buck converter
6. Performing speed tests, charging tests and discharging tests
7. Setting the necessary parameters using the computer software
8. Mounting the components onto the tractor

SPECIFICATION OF THE ELECTRICAL COMPONENTS

1. MOTOR

   Output power rating of 15KW
   A voltage input of 96v AC
   The maximum current it can withhold is 174 Amperes (AC)
   The maximum speed it can achieve is 6000rpm

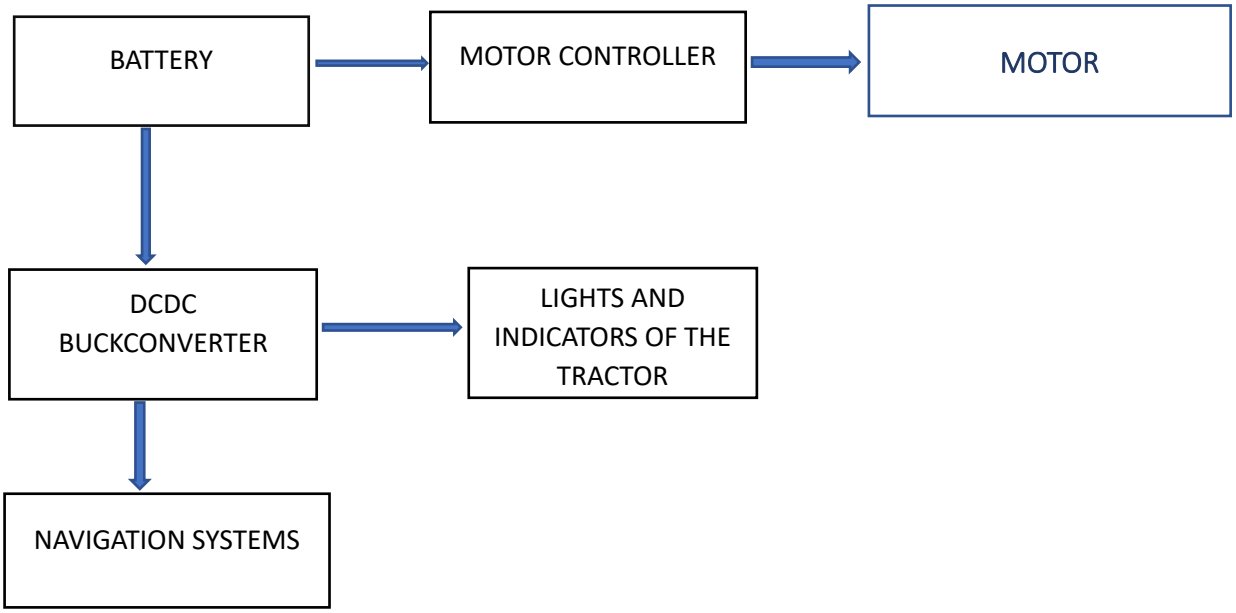
2. CONTROLLER

   Its working voltage is an average of 96v (80v to 144V) DC
   Its current input is 500A

3. BATTERY
   It has a capacity of 16KWh
   Output voltage of 106volts while fully charged
   The battery comprises of 32 cells that are connected in series. Each has a rating 3.31v

4. ACCELERATOR FOOT PEDAL
   Has an input voltage of 12v
   Varies the voltage from a range on 0v to 5v

POWER FLOW



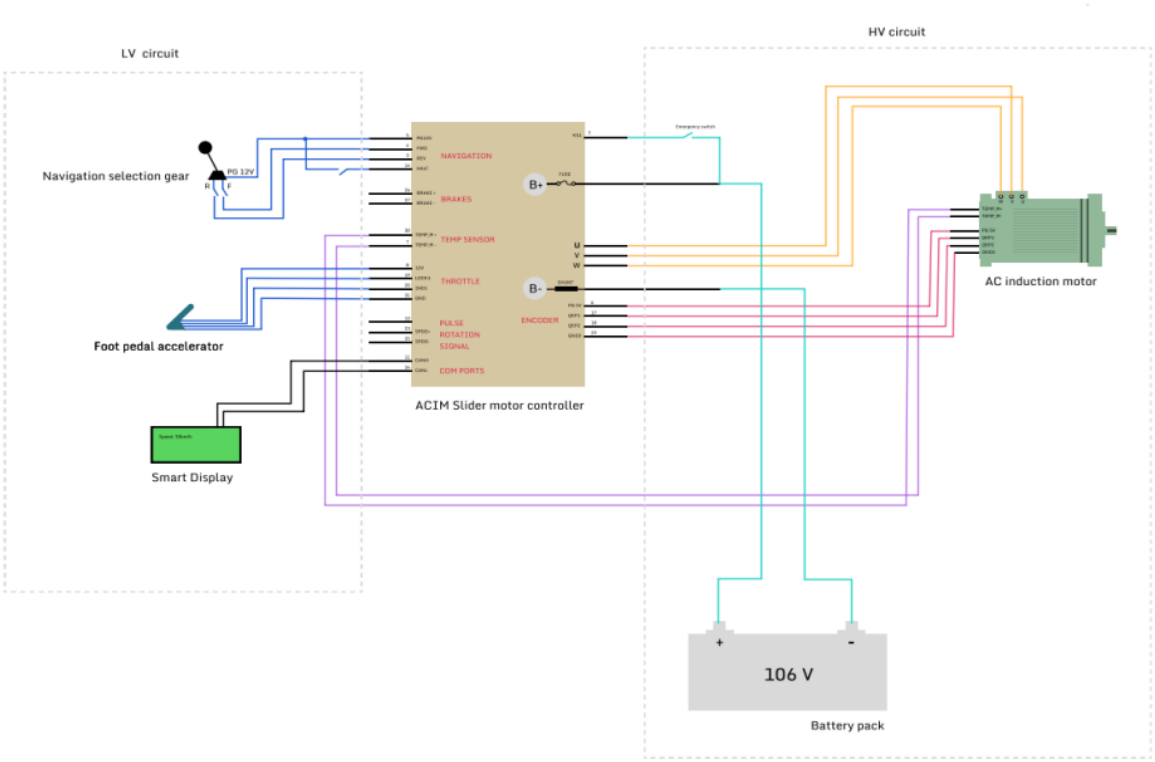
COMING UP WITH THE VOLTAGE AND LOW VOLTAGE CIRCUIT

After carefully going through the controller manual, we came up with two different voltage circuits.

i. High voltage circuit- This comprised of components that required an average voltage of around 96v DC in order to operate. They comprised of the controller and the display. This voltage was supplied by the battery having a rating of 106volts.

ii. Low voltage Circuit- This comprised of electrical components that required an average voltage of 12v, 5v and 3.7volts. From the manual, the navigation selection gear and the foot pedal accelerator required 12v while the encoder required 5volts. The navigation group requested us to provide them wit 5volts and 3 volts for their equipment while the

mechanical team requested us to provide them with 12 volts for the fanthat is meant to cool the motor



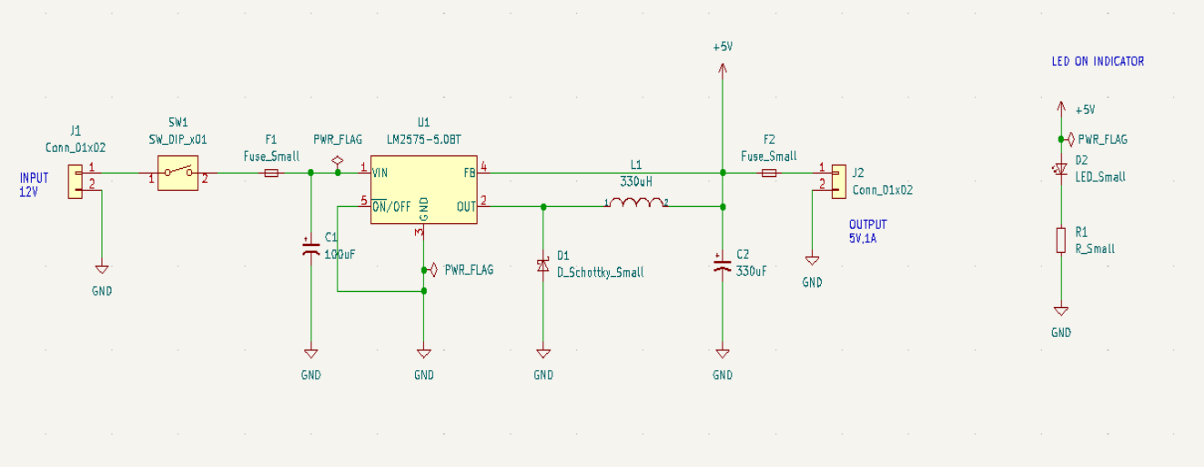
MODIFICATION OF THE BUCK CONVERTER

We were unable to procure a suitable wire harness with appropriate pin terminations for the 106v to 12volts buck converter. We therefore improvised by soldering 2.5 mm cables onto the pins and insulating them from each other in order to prevent short circuiting.

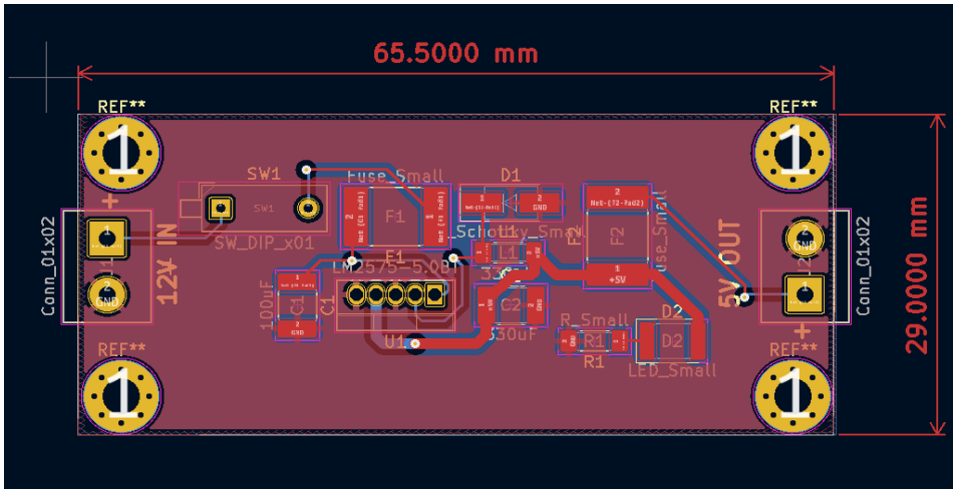
DESIGNING THE 12V TO 5V AND 3.7 VOLTS BUCK CONVERTER

The motor controller comes with a buck converter that is supposed to lower the 106volts supplied by the battery to 12 volts that is required by other external components such as the lights and indicators. This voltage required to be stepped down further to 5v and 3.7volts. To do that we simulated and designed a buck converter circuit.

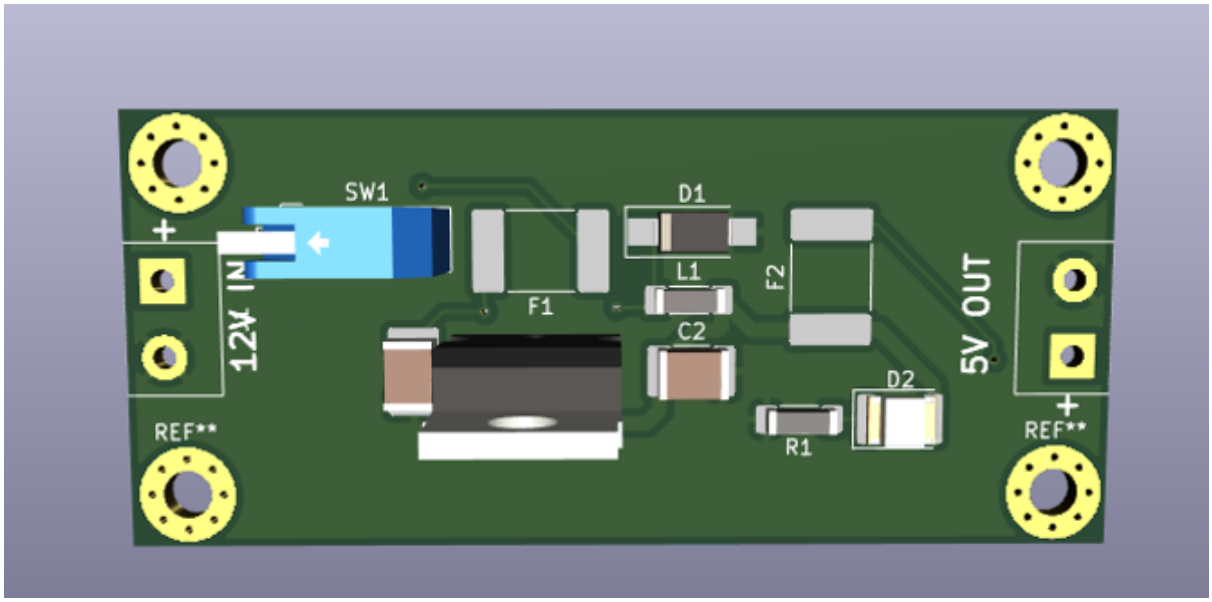
1. Schematic design



2. PCB design



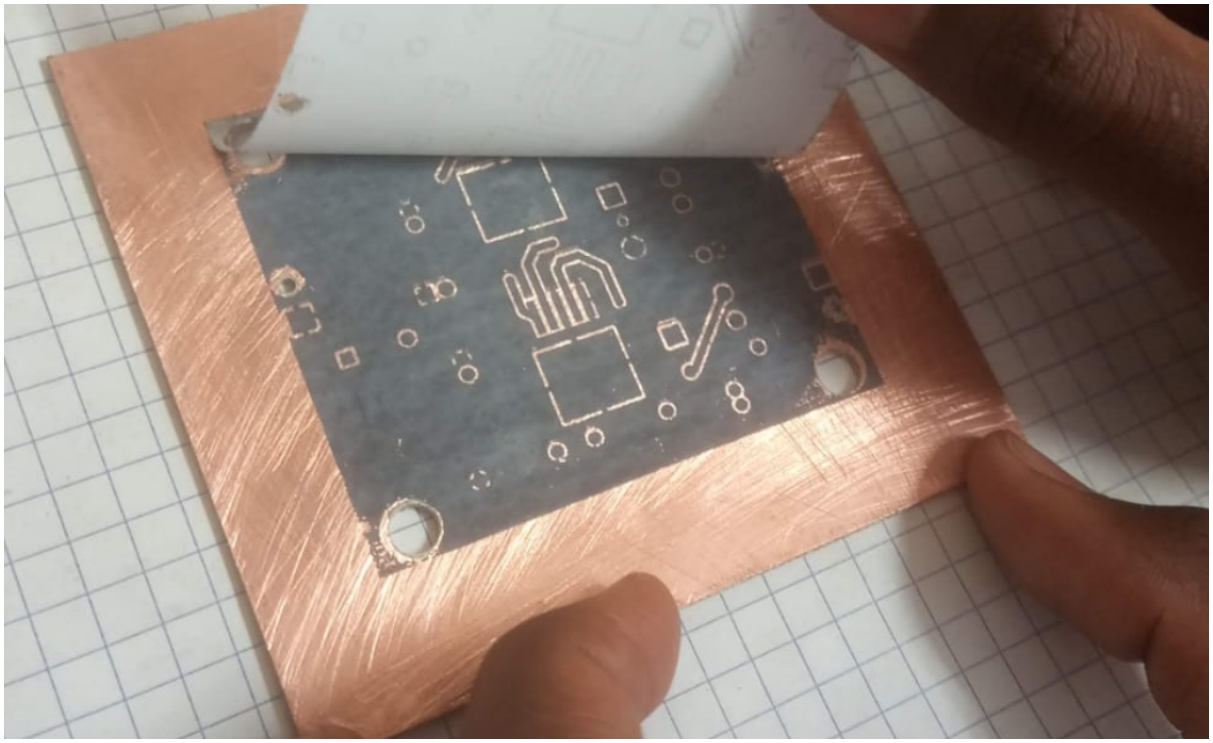
3. 3D view of the design



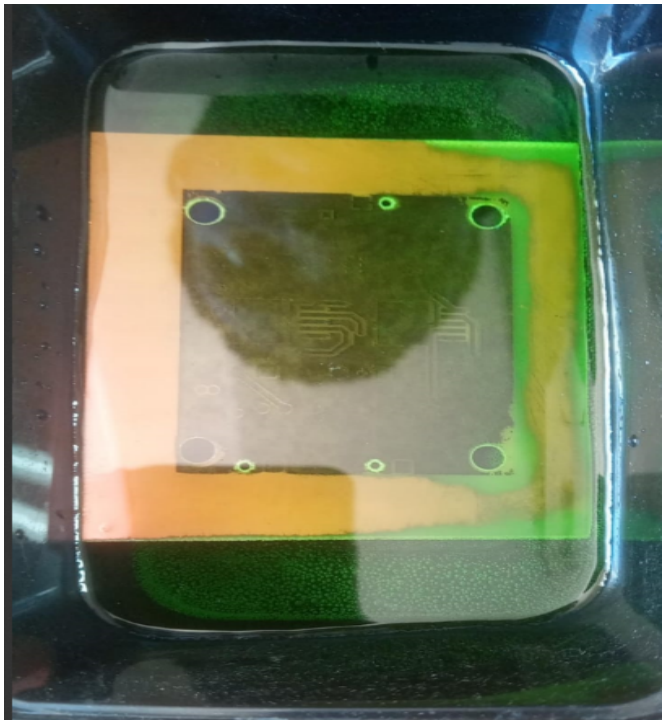
Before moving to the fabrication stage, we first tested the components on a breadboard to confirm if the expected voltage was produced in the output. The test was successful.

We then proceeded to the final stage i.e., fabrication. This involved printing the printing the PCB design onto a glossy paper, Imprinting the design on a copper plate and put it into a mixture of hydrochloric acid and hydrogen peroxide. Finally, we did the etching process and mounted the components on the PCB.

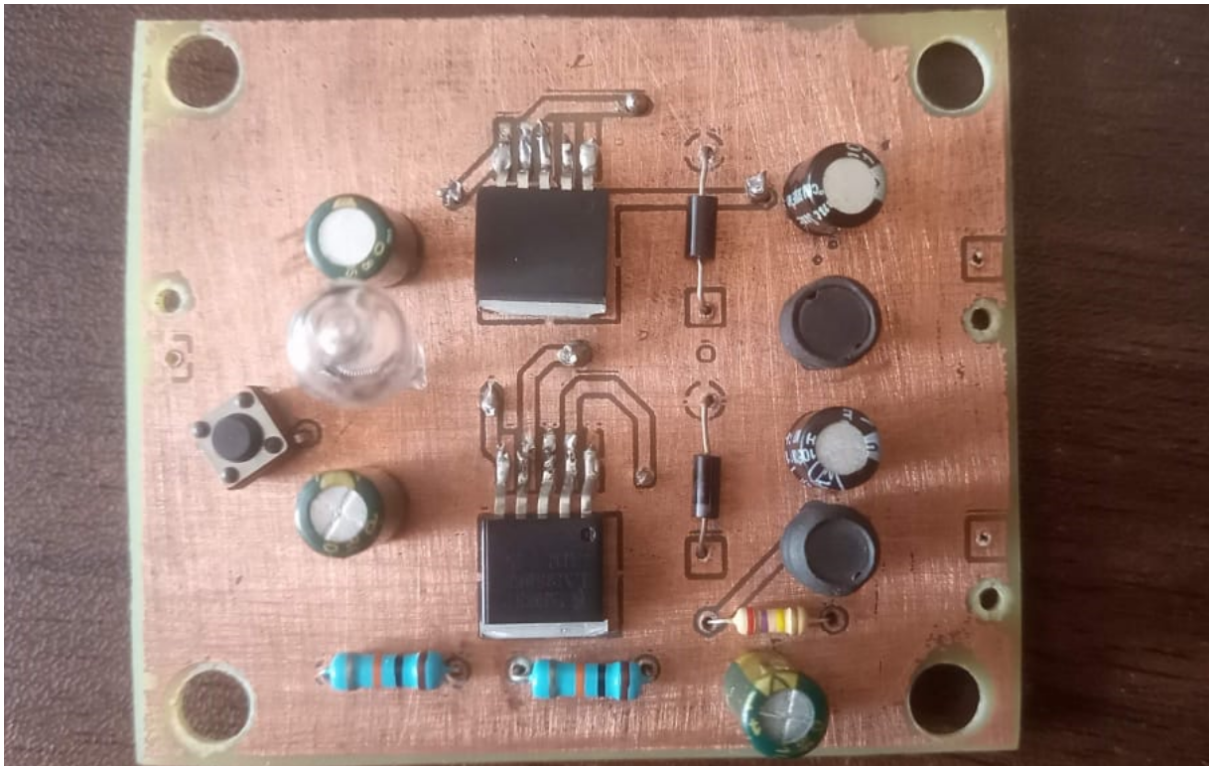
1. imprinting the copper plate with the PCB design



2. Dipping the copper plate into a mixture of HCL and Hydrogen Peroxide



3. The PCB after mounting the components

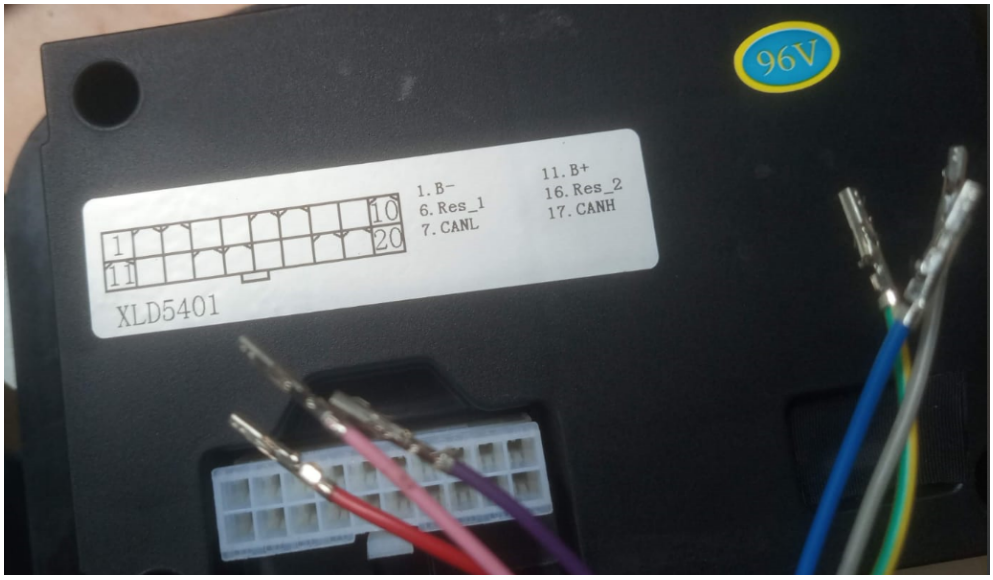


On testing the buck converter, we realized that the ground plane was causing short circuits and as a result we were not getting any output. To solve this, we redesigned the buck converter and removed the ground plane as shown below.

INTEGRATING THE DISPLAY TO THE CONTROLLER

The display was meant to indicate the battery level, the speed at which the motor is rotating and as well as whether the direction of rotation is forward or reverse. In order to connect the display, we first had fit 0.5mm cables onto the specific pins of the display as instructed. We then looped the Res_1 and Res_2 cables together. The B+ and B- cables were connected the battery respectively. Later on, we connected the CANH and CANL to the controller

1. Connecting 0.5mm cables to the display pins



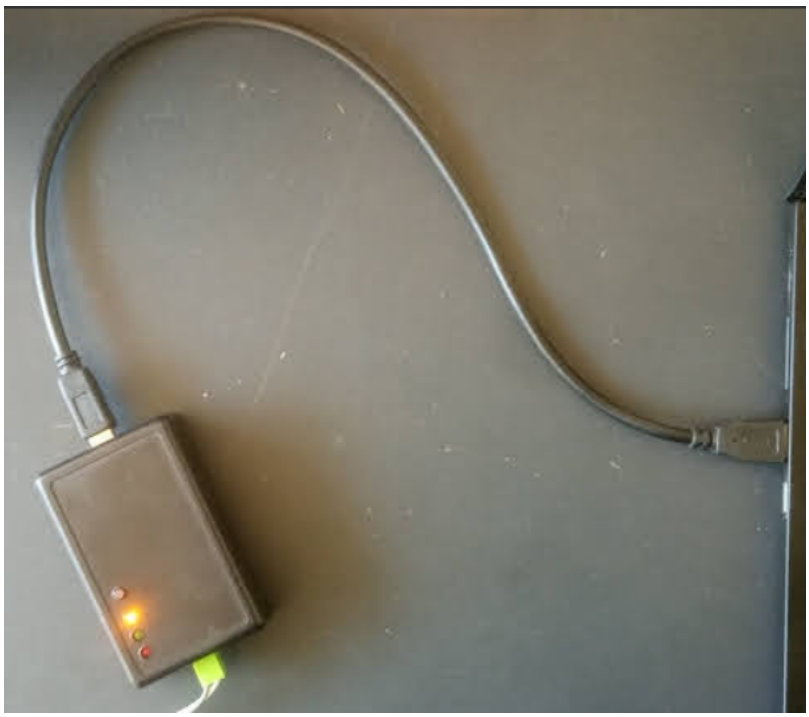
2. Display in operation

SETTING THE NECESSARY PARAMETERS USING THE CAN PROTOCAL

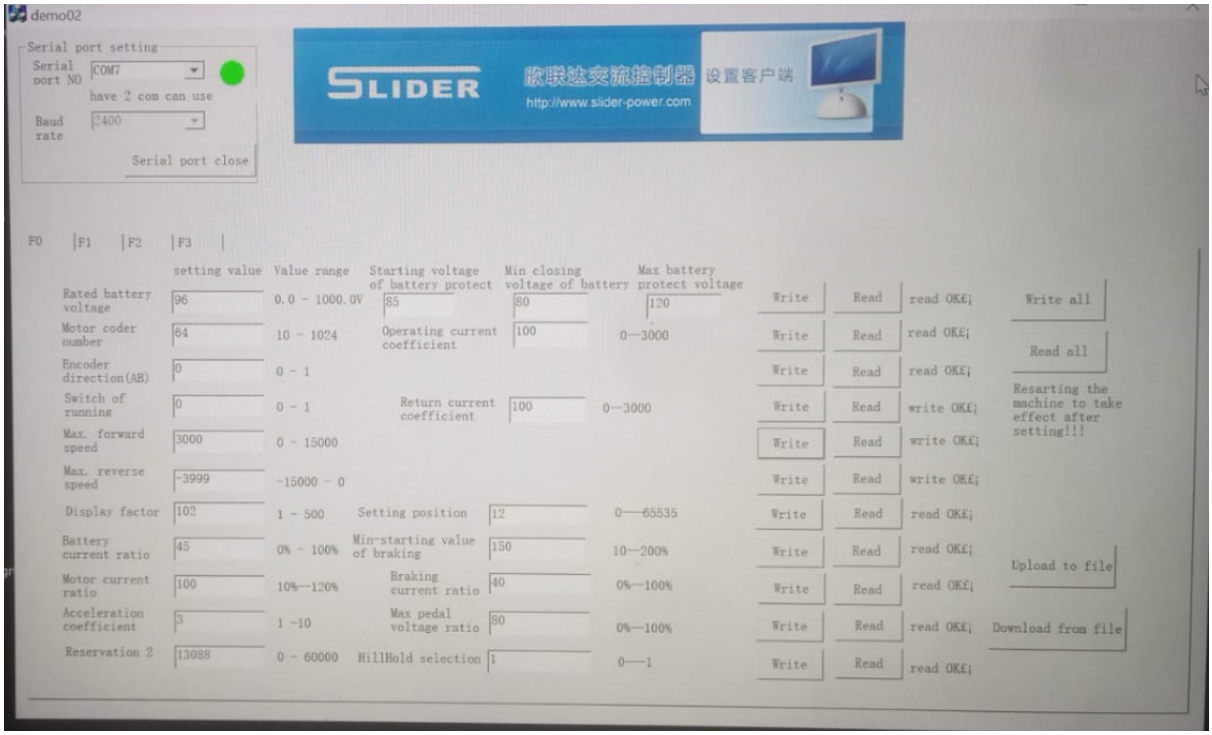
In order to view and set the necessary parameters for the controller, it was necessary to purchase a can module as well as install the software for the controller. We then went through the parameters and made adjustments to the maximum speed and the and the acceleration coefficient.

The maximum speed was set to 3000rpm and the speed coefficient was set to 1.

1. CAN module



2. User interface for the controller software



TESTING THE SPEED OF THE CONTROLLER

The maximum speed that could be achieved by the motor was 6000rpm. For safety purposes, the controller had been set to a speed of 4500rpm. This speed was tested using a tachometer. In order to match the speed of the motor to that of the initial engine, we set the speed to 3500 rpm

MOUNTING THE COMPONENTS ONTO THE TRACTOR

This was a collaborative exercise that was supposed to be done together with the mechanical team. This involved linking op the motor shaft with the flywheel of the gear box, mounting the battery to the chassis of the tractor and firmly screwing it to it. The accelerator pedal was then installed in a suitable position where one could easily accelerate. We then did the wiring of the entire electrical system and tested its motion.

1. Components mounted on the tractor

2. Wiring of the components together

OBJECTIVES THAT WERE NOT ACHIEVED

1. Testing the two back converters on the battery: We had a few issues connecting the 106v to 12v buck converter battery and hence we did not achieve getting the 12v output voltage
2. Testing the charging and the discharging rate of the battery: This was due to lack of enough time as well as the battery had not yet drained at all.
3. Fitting the battery charger on the tractor

RECOMMENDATION

1. Do more research on the specific type of buck converter we have and test it with the battery
2. Test the 12v to 3.7v and 5v and if necessary, make appropriate modifications
3. Test the charging and the discharging rate of the battery
4. Fit the battery charger onto the tractor