Low Cost Platform for Electric Drive Experimentations

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Client: Dr. Venkata Yaramasu

Client:

- **Dr. Venkata Yaramasu: Venkata.Yaramasu@nau.edu**
  - Assistant Professor
  - Research interests: Wind and photovoltaic energy, high power converters, model predictive control.
- **GTA: Han Peng: hp263@nau.edu**

Introduction

- dSPACE is an expensive platform that is being used in electric drives courses.
- MATLAB Simulink and dSPACE control desk are used to support this platform.
- Arduino board is the cheapest alternative.
- The project is about performing the dSPACE lab experiments and converting it to Arduino board by using MATLAB Simulink.

Project Motivation

Client needs this solution because:

- It is cheaper.
- The dSPACE converted to Arduino can still perform the intended tasks.
- Its interface is easy to work on.
- It is a great way for students to perform experiments and get access to their labs even if they are at their homes.

Project Approach

- As a team we did intensive research to understand the constraints and the requirements. We had to focus on many things to work on our labs, such as:

❖Simulink design.

❖Workflows.

❖Search for datasheets.

❖Security.

❖Tools/plugins.

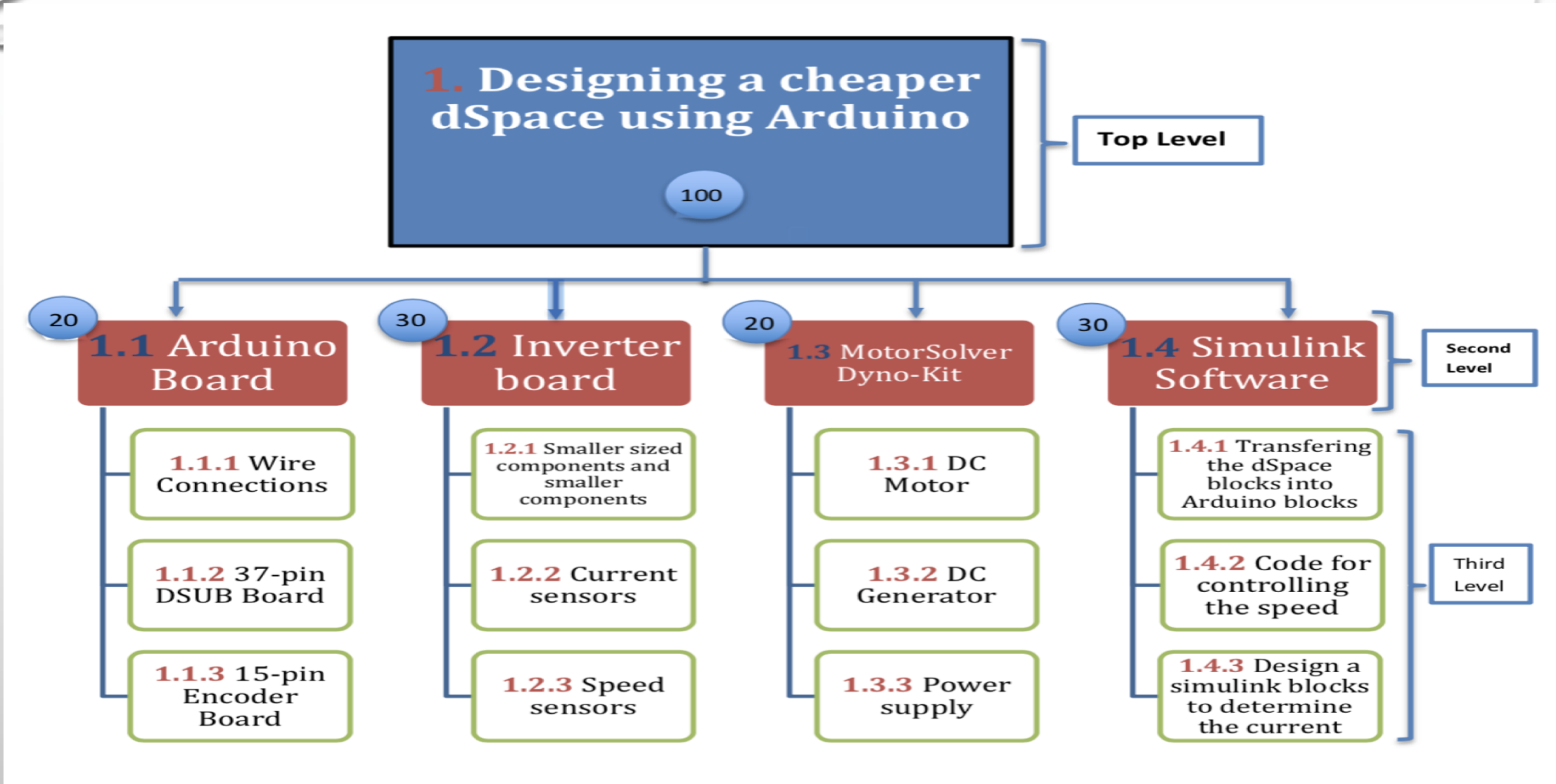
❖Gathering data.

Project Analysis

The encountered constraints included:

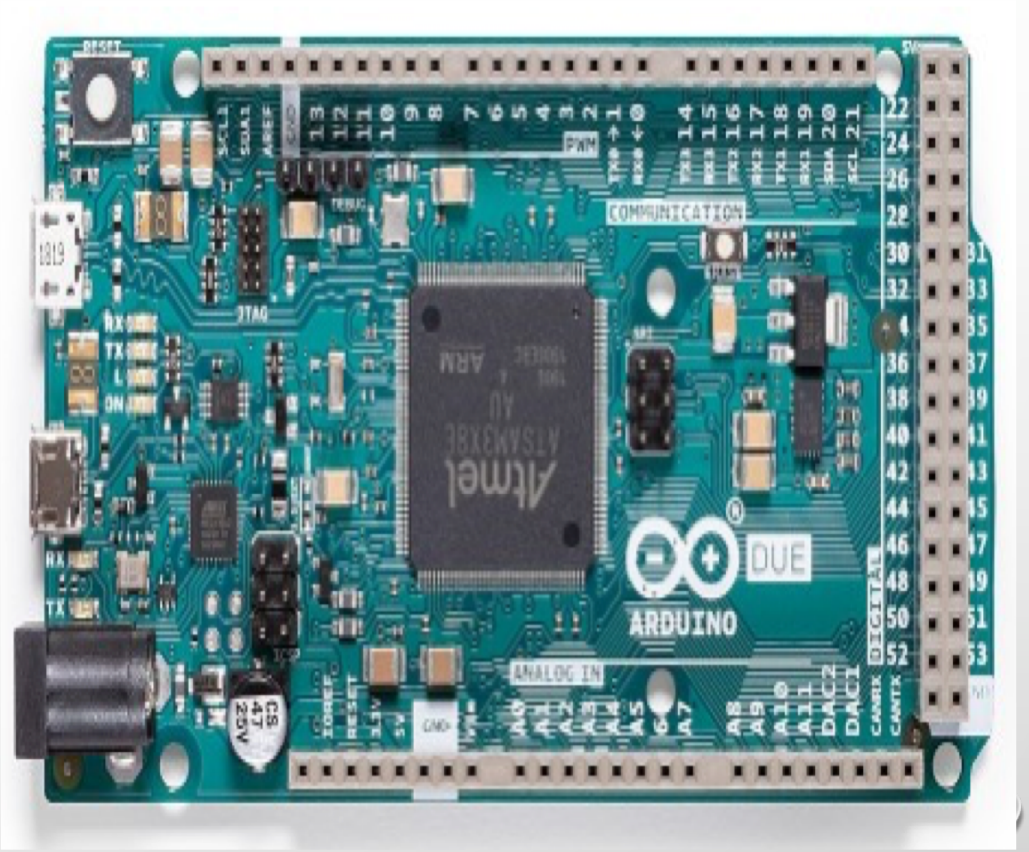
- ✓ Calculations of the motorsolver.
- ✓ Linking with MATLAB Simulink.
- ✓ Measuring the required current.
- ✓ Modifying the Arduino codes and creating the design.
- ✓ Double soldering for direct comparison between both platforms.

Subsystem Breakdown



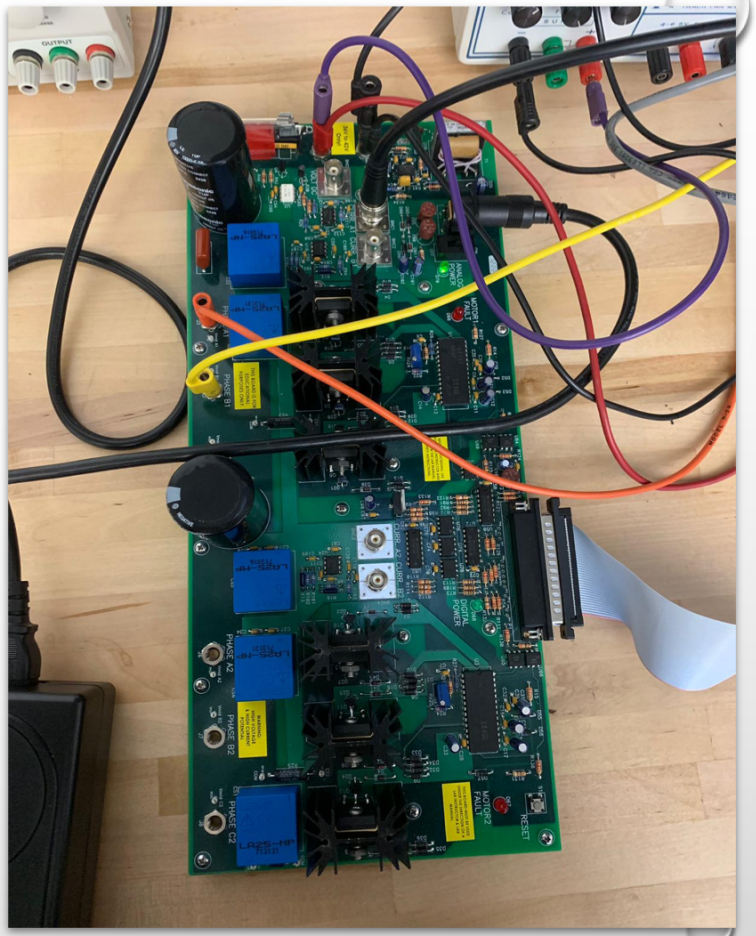
Subsystem 1: Arduino Board

- The Arduino board is the cheaper alternative for the dSPACE.
- Arduino board will be used to control the motor.
- With the right wiring and components, the Arduino can be used to control the dc motor.



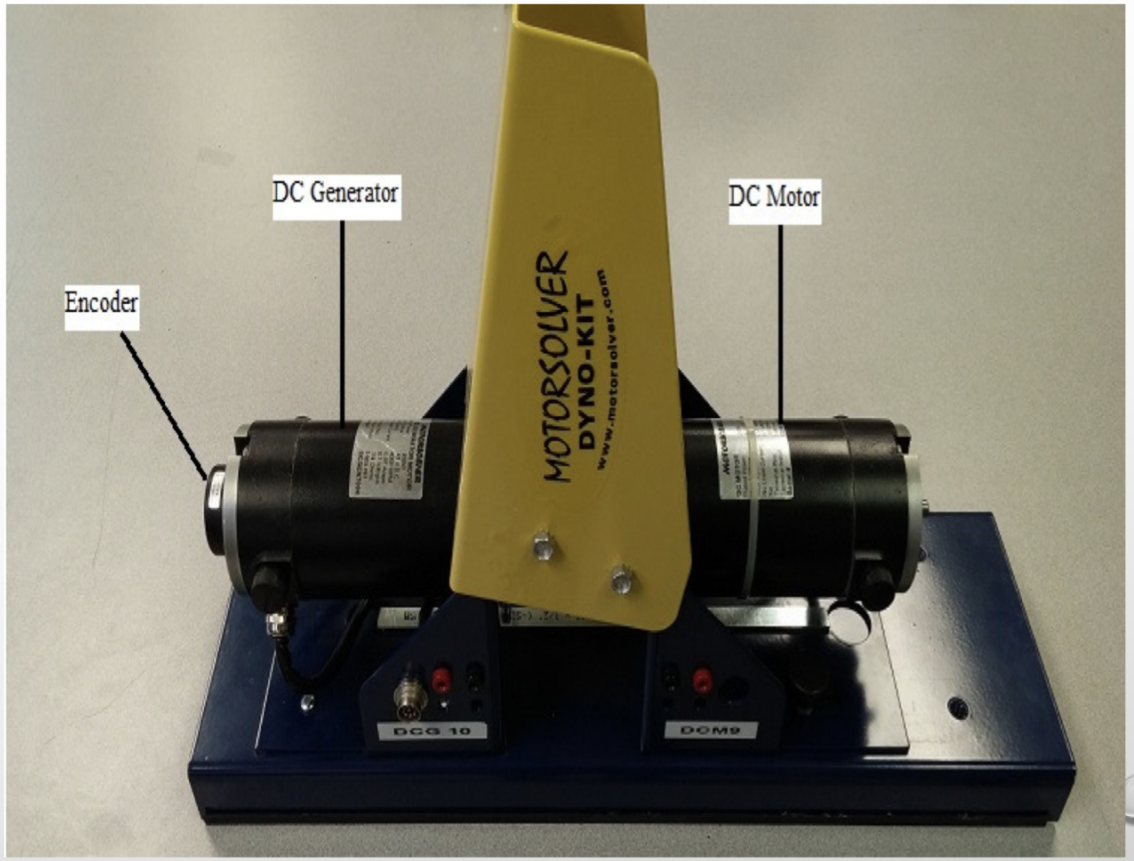
Subsystem 2: Inverter Board

- The inverter board is the link between the Arduino and the motor to operate the system.
- Inverter board will be used to run the motor and combine experiment for both Arduino and dSPACE to get results.
- The board can also be used to get important information such as, get current and voltage measurements.



Subsystem 3: Motorsolver

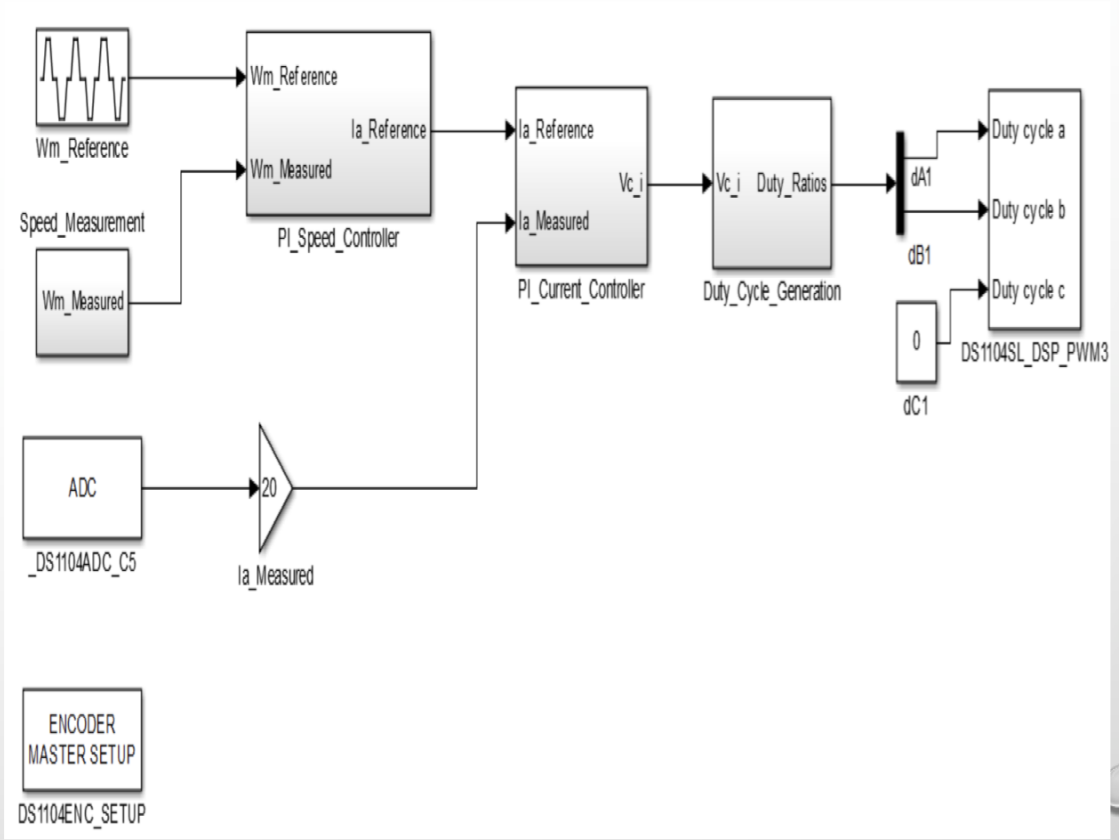
- **The motorsolver dyno-kit consist of:**
  - DC motor.
  - DC generator.
- **How DC motor subsystem related to the Arduino board?**
  - Works by connecting Arduino board to the DC motor using the 15-pin encoder cable.
- **How dc motor subsystem related to the inverter board?**
  - We supply the motor with power by connecting the inverter board using banana cables.



Subsystem 4: MATLAB Simulink

- MATLAB Simulink software is used to design a system to be controlled.
- The Simulink blocks are used to give specific commands in order to have a complete system.
- Converting dSPACE experiments using Simulink blocks by installing Arduino support package on MATLAB Simulink.

dSPACE Lab Design:



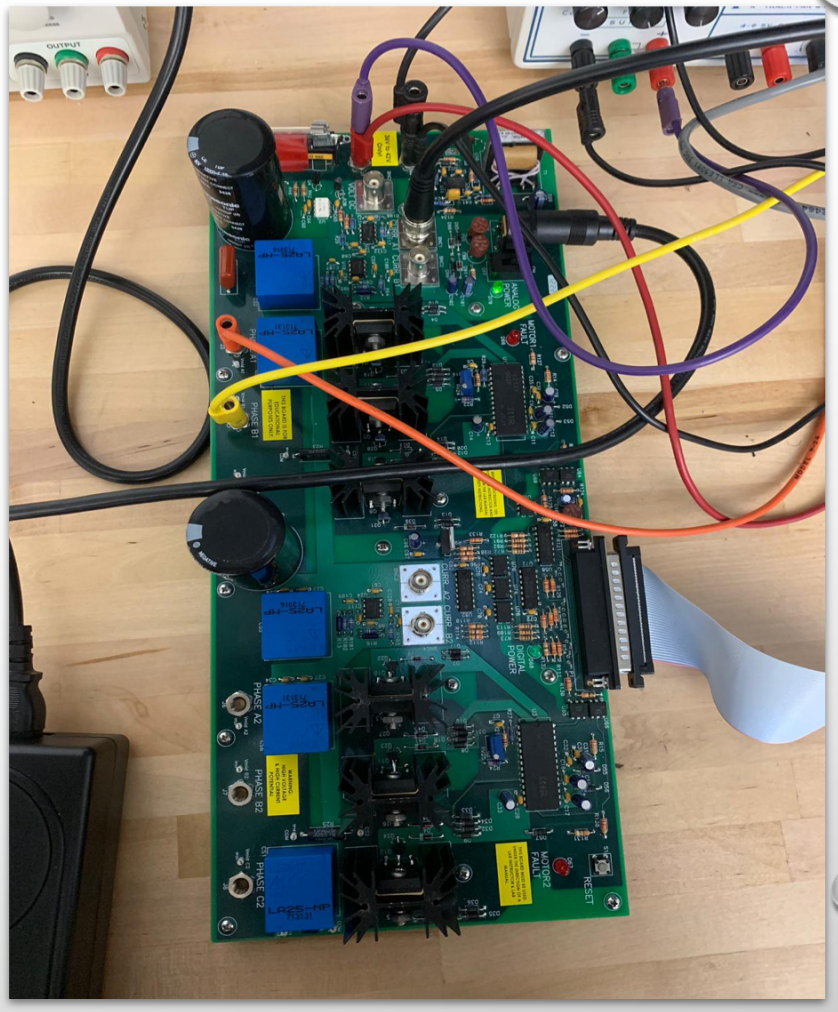
Responsibilities of Ali Muqeem:

- **Current measurement:**
  - Measured current for both Arduino and dSPACE by using BNC cables.
  - The current for the Arduino board is measured by using pins.
  - Used a converter for direct current comparison between the Arduino and dSPACE.

- **Wire soldering**
  - Double solder on a 15 pin encoder connector.
  - The idea of the soldering is to make a direct comparison between the two platforms.

- **Arduino blocks testing:**
  - The Arduino has a support package for MATLAB Simulink.
  - Testing the blocks had to be done with the Arduino.
  - Arduino starter kit

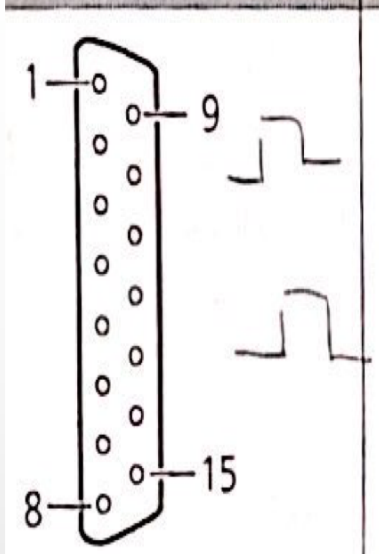
Inverter Board:



Responsibility of Ali Alfadhli:

- **Speed measurement:**
  - Measured speed in dSPACE based experiments to compare it with Arduino labs.
  - Used 15-pin encoder cable.
  - Researched the data sheets for the encoder to get the correct functions.
- **Modeling the Simulink design for Arduino:**
  - Converting dSPACE Simulink blocks to Arduino.
  - Arduino support package for MATLAB Simulink.
- **Modify the Arduino code inside the blocks:**
  - The code inside some of the blocks need to be modified.
  - making the system more stable.

Encoder Datasheet:



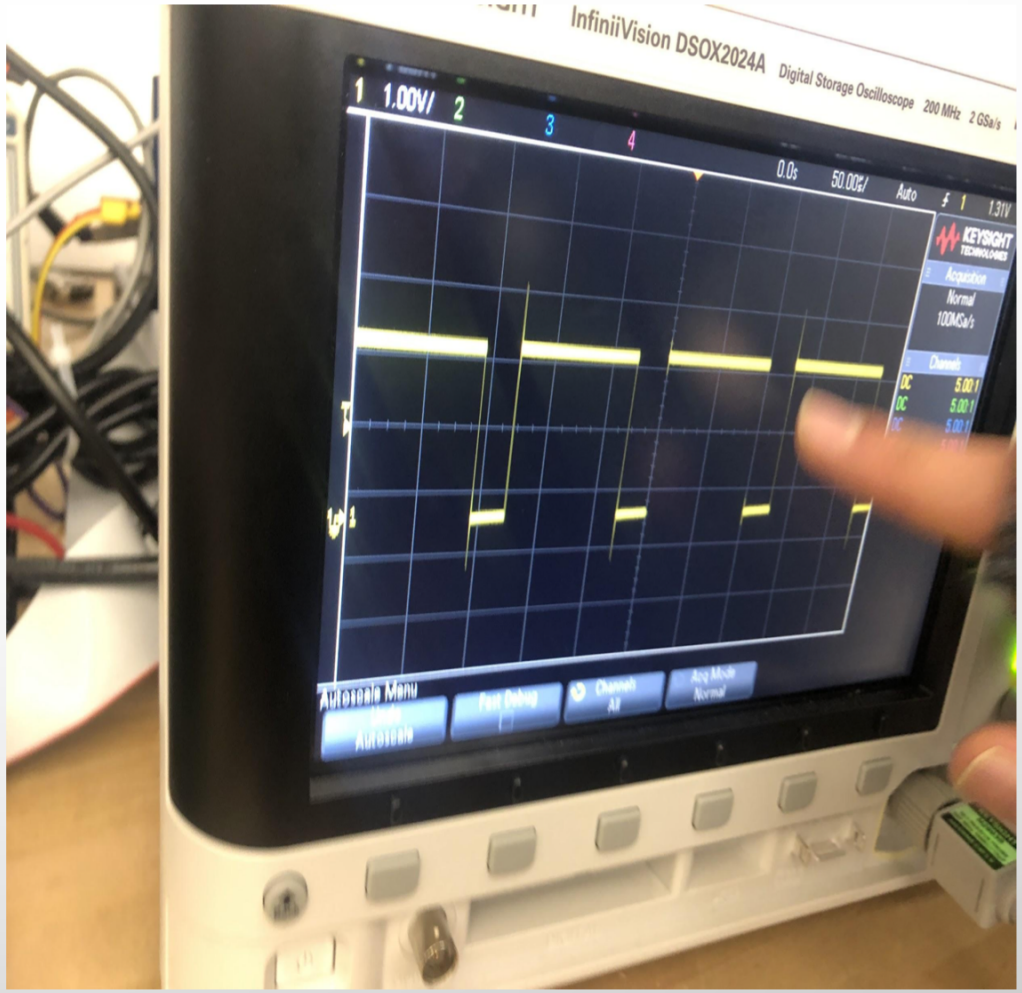
Connector (CP19, CP20)	Pin	Signal	Pin	Signal
	1	VCC (+5 V)		
	2	PHI0(x)	9	VCC (+5 V)
	3	$\overline{\text{PHI0(x)}}$	10	GND
	4	PHI90(x)	11	GND
	5	$\overline{\text{PHI90(x)}}$	12	GND
	6	IDX(x)	13	GND
	7	$\overline{\text{IDX(x)}}$	14	GND
	8	GND	15	GND

Responsibility of Salman Alajmi:

- **Collecting data from space labs:**
  - Using equations from the lab manual to get the correct measurement.
  - Comparing the Arduino results to dSPACE experiments and try to get the most accurate results.

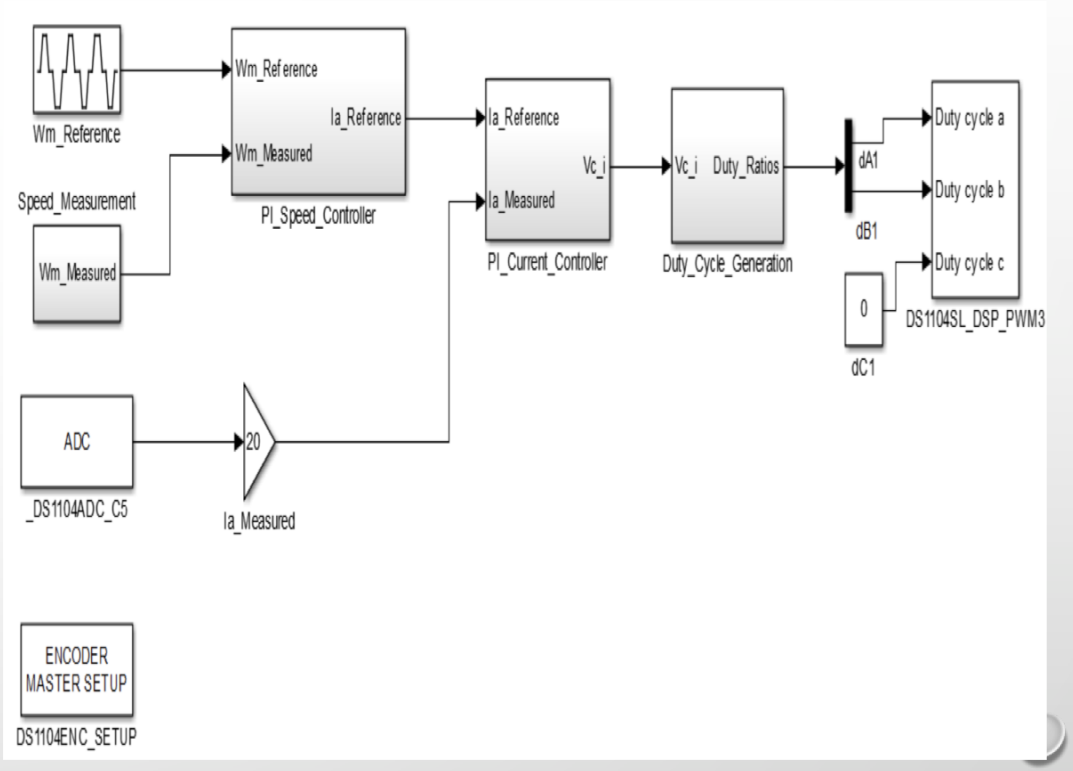
- **Sending 5V PWM signal:**
  - Using the Arduino PWM pins to send the signal.
  - The oscilloscope will display the signal in discrete.
  - We have two ways to measure the PWM:
    - PWM generators block.
    - Arduino PWM pin blocks.

PWM Signal:



Responsibility of Ahmad Alfaresi:

- **Running the dSPACE experiments:**
  - Taking parts in the dSPACE labs, running the experiments, and take measurements.
  - Test lab 1, lab2 and lab3 for dSPACE and the data and compare it with Arduino labs.
- **Wire connections:**
  - Connecting the Arduino wires with the right pins.
  - The Arduino pins numbers has to match the code.
- **Research:**
  - Search for solutions for Simulink errors.
  - Search for codes that can measure speed and PWM signal.
  - Check datasheets of the Arduino mega and due.

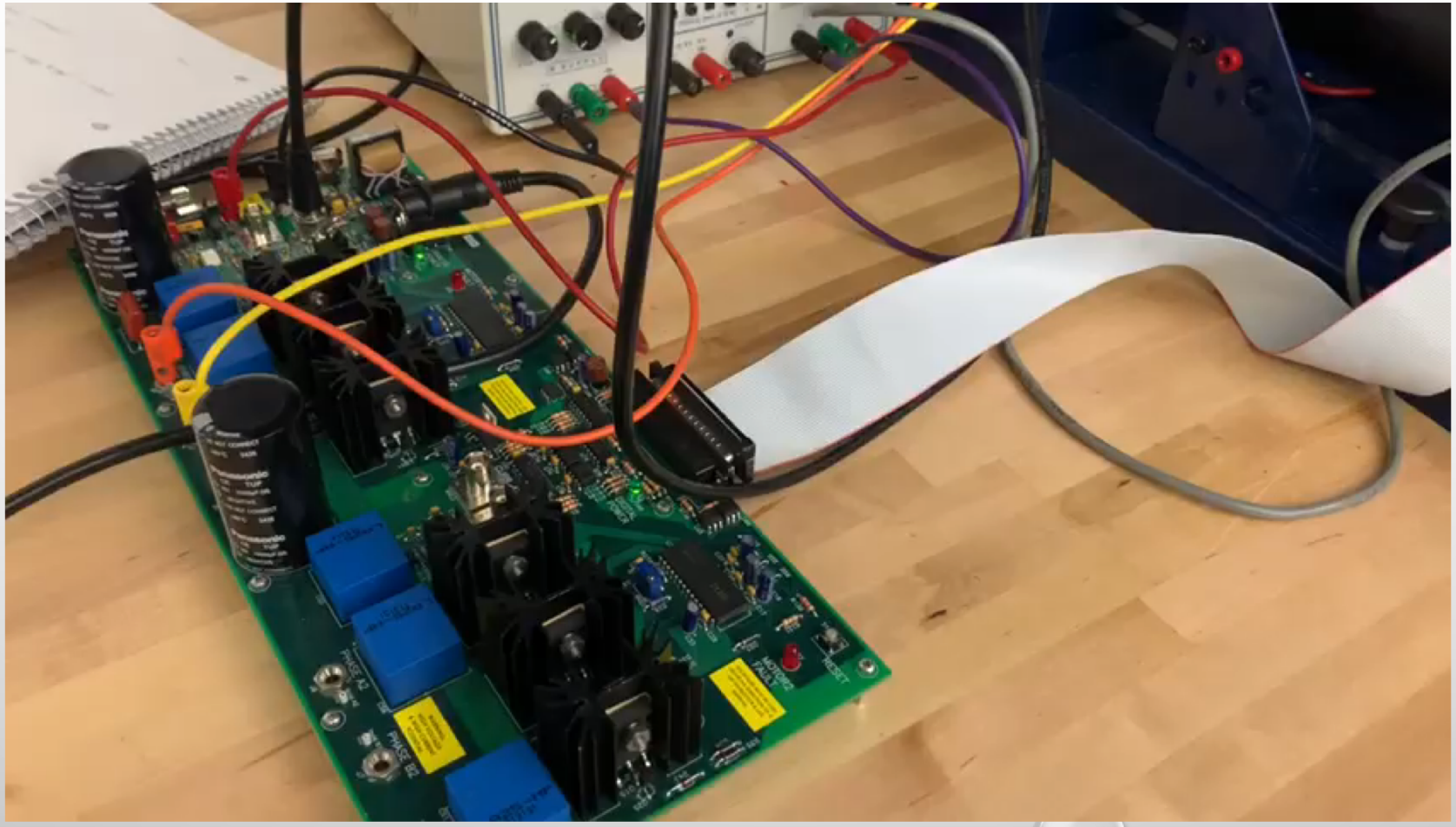


Technical Challenges

The team had technical challenges in regard to:

- Fixing the codes inside the Simulink blocks to make the system operate better.
- Working on the duty cycles to make sure that the motor runs properly for each lab.

Video of Our Simulation



Future Work to be Considered

In the future the client should focus on:

- The client should consider using a better inverter board with smaller components for students to work on.
- Providing Arduino lab test modules to test the Arduino board for students to understand the concept.

Conclusion

- **Goal of the project:**

➢ Performing the dSPACE lab experiments and converting it to Arduino board by using MATLAB Simulink.

- Achievement:

➢ In conclusion, the project needed some modifications, but the goal was achieved trough the different allocation of tasks across the team members.