1. ABSTRACT AND KEY WORDS: The abstract should be 150-300 words.

Electric Motors have become indispensable devices, taking significant roles in our environment such as appliances, hard drives, air conditioners, electric vehicles, and so on. These devices provide the users with the necessary and useful mechanical energy by the conversion of electric energy.

Traction Motors are considered a specific type of Electric Motors used for the propulsion of electric vehicles, namely locomotives, electric cars, electric aircraft, etc. With the employed traction motors in these devices, the required operations are satisfied [1].

Traction Motors, and most electric motors, require a certain type of power and speed management. To satisfy these needs, *variable-speed motor drives* are employed. The power from the battery pack is not directly ready for the use of the Traction Motor, but it is first modified and arranged in *Motor Drives* according to the need. The DC voltage should be converted to 3-Phase output to compose the control of *AC Motors*. These drives control the *torque, speed, and position* outputs of the associated electric motor. In most traction motor applications, the accurate control of speed and torque is of great importance due to the critical and sensitive operation requirements. Furthermore, the immediate need for energy saving and efficiency is also carried on by electric drives and controllers. Thus, electric drives perform control and efficient use of energy in the electric-based industry.

In this project, an electric drive design and control of it will be carried out. There will be two separate *Printed Circuit Boards (PCBs)* design for Power and Control Circuits.

CONTROL BOARD	POWER BOARD
1) Fault Circuit	Power Board will be composed of:
2) Gate Driver Interface	*1))* V-BUS Filter Circuit
3) Current Sensor Interface	*2)* V-BUS Voltage Sensing Circuit
4) Voltage Sensor Interface	*3)* Gate Driver Circuits
5) Temperature Sensor Interface	*4)* Driving MOSFET Connections
6) Power Supply Interface	5) Gate Driver Fault Circuit
7) CAN Interface	6) Connectors
8) Resolver	
10) F28379D-LAUNCHPAD	
11) Connectors	

Key words: *Electric Drives, Traction Motors, Variable speed motor drives, AC Motors, torque & speed & position control, Printed Circuit Board, PCB, Protection.*

2. PURPOSE: The purpose of the project and the expected outcomes should be included in this section.

The ultimate aim of this project is to provide precise and accurate control of electric energy to drive a 3-Phase AC Traction Motor. To fulfill this main particular goal, the aforementioned sub-circuit sections must work coherently. The purposes of these sub-sections are as follows:

CONTROL BOARD	
SUB-CIRCUITS	PURPOSE
Fault Circuit	External Under and Over Voltage, Current and Temperature protection.
Gate Driver Interface	Providing a robust communication between Gate Drivers and Control Board.
Current Sensor Interface	Reading the current values of each phase motor terminals and delivering it to the FAULT circuit for further safety.
Voltage Sensor Interface	Reading the voltage values of each phase motor terminals and delivering it to LAUNCHPAD for the track of motion.
Temperature Sensor Interface	Reading the temperature values of Driving MOSFETs, DC Bus Capacitors, and DC Bus Terminal.
Power Supply Interface	Precise filtering of the 12V input power, conversion to 5V and 3.3V for the use of ICs.
CAN Interface	Providing isolated power supply for CAN Transceiver, and constituting a robust communication between the Circuits and Digital Signal Processor.
Resolver	Converting the mechanical movement of the motor, and extracting the degree of rotation information from it.
F28379D-LAUNCHPAD	Collecting the data from other sub-circuits, monitors them and provides the user with precise control of the operations.
Connectors	Connecting Control and Power Board.

POWER BOARD	
SUB-CIRCUITS	PURPOSE
V-BUS Filter Circuit	Filtering the High Bus Voltage.
V-BUS Voltage Sensing Circuit	Scaling down the 0-1200 VDC Bus voltage to 0-3 VDC for further measurement and control.
Gate Driver Circuits	Driving both High Side and Low Side MOSFETs for each phase.

Driving MOSFET Connections	Connecting the Gate Driver Circuits with Driving MOSFETs.
Gate Driver Fault Circuit	Combining HS and LS RDY and /FLT outputs of Gate Drivers and constituting a fault signal for each phase.
Connectors	Connecting Control and Power Board.

3. SUBJECT: Please give a brief summary about the subject, including previous efforts. A few references are expected in this section.

Motor drivers are the interfaces between the control circuits and motors. Motors demand a higher amount of current and voltage compared to control circuits. Thus, motor drivers take and process the control signals and convert them into higher-current signals that run the motors [2]. This project focuses on "Variable Frequency Drives (VFD)". It is of great importance to know that given the same speed and torque characteristics, variable frequency drives and AC squirrel cage motors are cheaper compared to DC drives and DC Motors [3]. These drives control the speed of the motors by varying the frequency of the input voltage. The input voltage of the system in this project is not 3 Phase AC signal, but a fixed DC voltage from the DC Bus, in other words, the system will start from the DC Bus. The block diagram and the simple circuits of the design is shown in Figure 1.

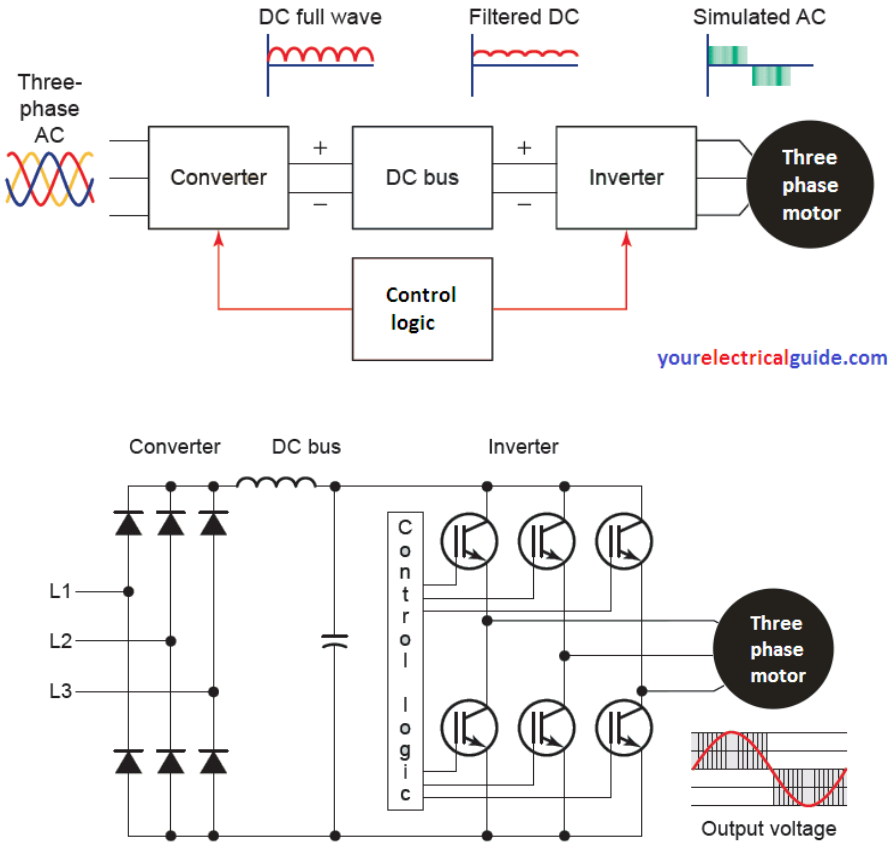

Figure 1: Block diagram and Circuits of a VFD

VFDs provide the control of speed, torque and direction of AC Motors. First, the 3-Phase fixed frequency AC voltage is converted to a DC voltage. Then, the DC voltage is converted into a variable frequency 3-phase AC voltage by the inverter [4].

Converter: A rectifier circuit that aims to convert fixed Frequency 3-Phase AC voltage into DC voltage. This part will not be populated in this project since the voltage will be directly taken from the DC Bus.

DC Bus: A connection between the DC voltage and inverter. The rectified voltage is filtered in this section and connected to inverter for further management. (This section will be populated on Power Board)

Inverter: Converts the incoming DC voltage into variable frequency 3-Phase AC Voltage and connects to the

motor. (This section will be populated on Power Board)

Control Logic: This system controls the frequency of the voltages by generating pulses for power semiconductors populated in the inverter. A DSP is required for this section. Also, the critical parameters such as current, voltage and temperature will be monitored and controlled by Control Logic. (This section will be populated on Control Board)

In addition, the input voltage is reduced with frequency to prevent any damage to the motor. Following this working principle, the motors are driven according to the requirements [3].

4. SOCIAL IMPACT: This section should include how your proposal addresses domestic and global issues.

Currently, the need for traction motors is immense. Electric cars, trains, aircrafts, etc. will be widely used in the future due to the environmental and economic concerns. There are already variety of companies producing their own Electric Vehicles, and slowly stopping the production of internal combustion engines. The electric motors require drives and controllers. As the popularity of electric vehicles and traction motors increase, the need for electric drives and control mechanism increase as well. The proposal in this project will refer to the need of electric drives and control of it. A Power Board that provides the control of high power to be delivered to the motors, and a Control Board that provides the precise control of faulty cases and monitoring the critical parameters will be designed and printed. It is important to point out that the boards will be controlled by F28379D-LAUNCHPAD embedded algorithms and will be communicating each other via on board connectors. This design will be used to satisfy the needs of a traction motor in an efficient and environmentally friendly manner.

5. METHOD:

1) Literature Review: A research for the Motor Drives and Controllers will be conducted. I will learn the main principles and important details of the design and modify it to the meet the requirements.

2) Schematic Design: I will draw the schematics for both Power and Control Boards.

3) Component selection: Available components on the market will be selected and footprints will be drawn.

4) PCB Board Design: I will design the PCB Boards paying significant attention to EMI noise. After the design, the components will be populated on the boards.

5) F28379D-LAUNCHPAD: I will learn how to use the mentioned DSP to control the boards.

6) Functionality Testing: I will test the PCB and drive an AC Motor.

6. SUCCESS CRITERIA:

The project will be considered successful if:

1. The circuit schematics are drawn and explained.
2. Power and Controller Circuit PCB Boards are populated, and the functionality is tested.
3. The AC Motor is driven under control.

References

[1] R. Mathur, «What is Motor Driver,» 26 September 2017. [Çevrimiçi]. Available: https://sproboticworks.com/blog/choosing-the-right-motor-driver. [Erişildi: 7 July 2021].

[2] A. Sharma, «VFD Working Principle,» 5 10 2019. [Çevrimiçi]. Available: https://www.yourelectricalguide.com/2017/12/variable-frequency-drive-vfd-working-principle.html.

[3] «Invertek Drives,» 2016. [Çevrimiçi]. Available: https://www.invertekdrives.com/support/iknow/vfd-fundamentals/what-is-a-variable-frequency-drive.