VFD Motor Controller

Mackenzie Miller

Andrew Nguyen

Aidan Rader

Ryan Regan

**Interface Control Document**

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Interface Control Document

for

VFD Motor Controller

Prepared by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Author Date

Approved by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Project Leader Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

John Lusher II, P.E. Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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# Overview

This Interface Control Document (ICD) for the VFD Motor Controller provides an overview of the requirements and specifications for a Variable Frequency Drive that will be used to control a motor and it’s speed. Created by Ryan Regan, Andew Nguyen, Mackenzie Miller, and Aidan Rader, this document describes the physical, electrical, thermal, and communication interfaces for the system.

**Key Sections:**

* Physical Interface: This section depicts the physical aspects of the VFD including weight, dimensions, and physical/spatial requirements.
* Thermal Interface: The VFD includes a thermal monitoring system using the VFO pin and ITRIP pins that will shut the system down if the temperature levels are too high
* Electrical Interface: The electrical specifications include motor power, DC supply voltage, and the microcontroller’s stepped-down voltage supply. The DC voltage will be regulated by an H-bridge, and optoelectronic circuits will be used to isolate the microcontroller from the high voltage section of the system.
* User Interface: The VFD’s firmware allows the user to control the on/off functionality of the system as well as the speed of the motor with a button and potentiometer. The microcontroller can be plugged into a computer to view other different diagnostic feedback variables from the system.
* Communication Protocols: Optoelectronics will be used for communication between the high-voltage power control and the low-voltage microcontroller. Additionally, the system will use UART for serial communication and will have USB connectivity for programming and debugging.

# References and Definitions

## 2.1 Definitions

AC Alternating Current

DC Direct Current

GUI Graphical User Interface

ICD Interface Control Document

MHz Megahertz (1,000,000 Hz)

MCU Micro Controller Unit

mA Milliamp

mW Milliwatt

N/A Not Applicable

TBD To Be Determined

VFD Variable Frequency Drive

# Physical Interface

## 3.1 Weight

The VFD motor controller may weigh up to 6lbs. The motor itself may weigh up to 13lbs.

## 3.2 Dimensions

### 3.2.1 Dimension of Optoelectronics and Feedback

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Diameter** | **Length** | **Width** | **Height** |
| Digital Isolator | N/A | 0.406” | 0.406” | 0.104” |
| Analog to Digital Optoisolator | N/A | 0.442” | 0.354” | 0.158” |
| Operational Amplifier | N/A | 0.382” | 0.25” | 0.400” |
| 12 Pin Connector | N/A | 0.854” | 0.389” | 0.271” |
| 8 Pin Connector | N/A | 1.089” | 0.447” | 0.272” |

*Table 1: Optoelectronics and Feedback Dimensions*

### 3.2.2 Dimensions of MCU

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Diameter** | **Length** | **Width** | **Height** |
| dsPIC33CK256MP508 | N/A | 0.394” | 0.394” | 0.039” |
| LM2595s-3.3 Buck Converter | N/A | 0.400” | 0.180” | 0.450” |
| IRM 15-15 AC/DC Connector | N/A | 2.06” | 1.07” | 0.945” |
| 20 Pin connector | N/A | 1.68” | 0.276” | 0.335” |
| 5 Pin Connector | N/A | 0.314” | 0.433” | 0.370” |
| 3 Pin Connector | N/A | 0.600” | 0.322” | 0.393” |
| Potentiometer | 0.236” (actuator) | 0.433” | 0.386” | 1.173” |

*Table 2: MCU Dimensions*

The physical dimensions of the subsystem will be relative to the size of the user’s laptop and the size of the motor, both should not exceed the size of a standard tabletop.

### 3.2.3 Dimensions of Rectifier & DC Link

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Diameter** | **Length** | **Width** | **Height** |
| VUE75-06NO7 | N/A | 1.850” | 1.193” | 0.799” |
| IKCM30F60GD | N/A | 1.417” | 0.827” | 0.201” |
| Capacitor(s) | N/A | TBD | TBD | TBD |
| Inductor(s) | N/A | TBD | TBD | TBD |

*Table 3: Rectifier & DC Link Dimensions*

# Thermal Interface

## 4.1 Temperature Sensing

The power control shall monitor the temperature via the VFO pin, and if the VFD temperature rises above a safe value, the ITRIP pin will automatically shut the project down to avoid damaging parts.

# Electrical Interface

## 5.1 Primary Input Power

The motor being used is 0.25HP producing 186.425W of power. The voltage supplied to the system is 295VDC which is then taken in by the H-bridge to generate a line-to-line voltage of 208V. 15VDC power is supplied to the MCU from the AC/DC power supply fed by the main power. This voltage will be stepped down to 3.3V for the MCU to use.

## 5.2 Voltage and Current Levels

|  |  |  |
| --- | --- | --- |
| **Component** | **Voltage (V)** | **Current (mA)** |
| dsPIC33CK | 3.3V | 50mA |
| IKCM30F60GD | 600V | 60A |

*Table 4: Maximum Voltage and Current Values*

## 5.3 Signal Interfaces

Pulse Width Modules will be sent from the microcontroller to the power control of the VFD project using optoelectronic circuitry to ensure the microcontroller does not come into contact with the high voltage in the power control.

Three phase voltage values will be sent to the microprocessor from the power control using optoelectronic circuitry to ensure that the microprocessor does not come into contact with the high voltage in the power control.

## 5.4 User Control Interface

One feature of the VFD’s microcontroller will be a potentiometer that allows the user to control the frequency of the three phase PWM’s sine wave by increasing the step size that the program uses to step through a sine wave table. Increasing the PWM signal’s frequency will increase the speed of the motor. The user will be able to change the frequency by turning a potentiometer. Another feature of the microcontroller is the start/stop button. This will give the user the option to turn the motor on and off without having to disconnect the system’s power. In addition to the physical user interface, the VFD will display several debug variables to the UART console in MPLAB X IDE when connected to a computer. The user will be able to view the voltage, current, and temperature in a UART console.

|  |  |
| --- | --- |
| **Pin** | **Function** |
| 1 | PWM1H |
| 2 | GPIO |
| 3 | PWM1L |
| 4 | GPIO |
| 9 | MCLR |
| 11,32,50,70 | VSS |
| 12,31,51,71 | VDD |
| 17,22,39,44 | GPIO |
| 19 | GPIO (Potentiometer) |
| 24 | GPIO (LED 2) |
| 25 | AVDD |
| 26 | AVss |
| 34 | Clock input |
| 37 | GPIO (LED 1) |
| 42 | GPIO (Relay) |
| 60 | PGD1 |
| 61 | PGC1 |
| 68 | UART TX |
| 69 | UART RX |
| 75 | PWM3H |
| 76 | PWM3L |
| 78 | PWM2H |
| 80 | PWM2L |

Table 5**:** Pin interface for DSPIC33CK256MP508 Microcontroller

# Communications / Device Interface Protocols

## 6.1 Optoelectronic Communications

The high voltage power control of the VFD will communicate to the low voltage or MCU via optoelectronics, or light to ensure that the MCU is not overpowered by the 120 VAC in the analog power control side.

## 6.2 Firmware and MCU Communications

The microcontroller is programmed with C code through MPLab’s X IDE and will have several firmware implementations such as an on/off button’s functionality and a three-phase PWM wave’s frequency control.

## 6.3 Device Peripheral Interface

The MCU will use UART interface for serial communication between devices. This is what will allow a laptop to communicate with the microcontroller through USB connection.

## 6.4 Host Device

The C code shall be ran on MPLab’s X IDE, which should be downloaded on the users computer. This will be used to program the microcontroller and output any debug variables necessary while the system is running.