WindTel Documentation

1. System Architecture and Interfaces

WindTel System Block Diagram

The WindTel embedded system consists of four microcontroller-based hardware modules partitioned according to their functionality. These modules are categorized as: Master Module, Pressure Module, Balance Module and Dynamic Measurements Module. Each of the architectures of these modules are explained in more detail in the following sections. A Universal Serial Bus (USB) charger connected to a power outlet will serve has the system power supply. Fig. 1 and Fig. 2 illustrate how each of these hardware modules interface with each other.

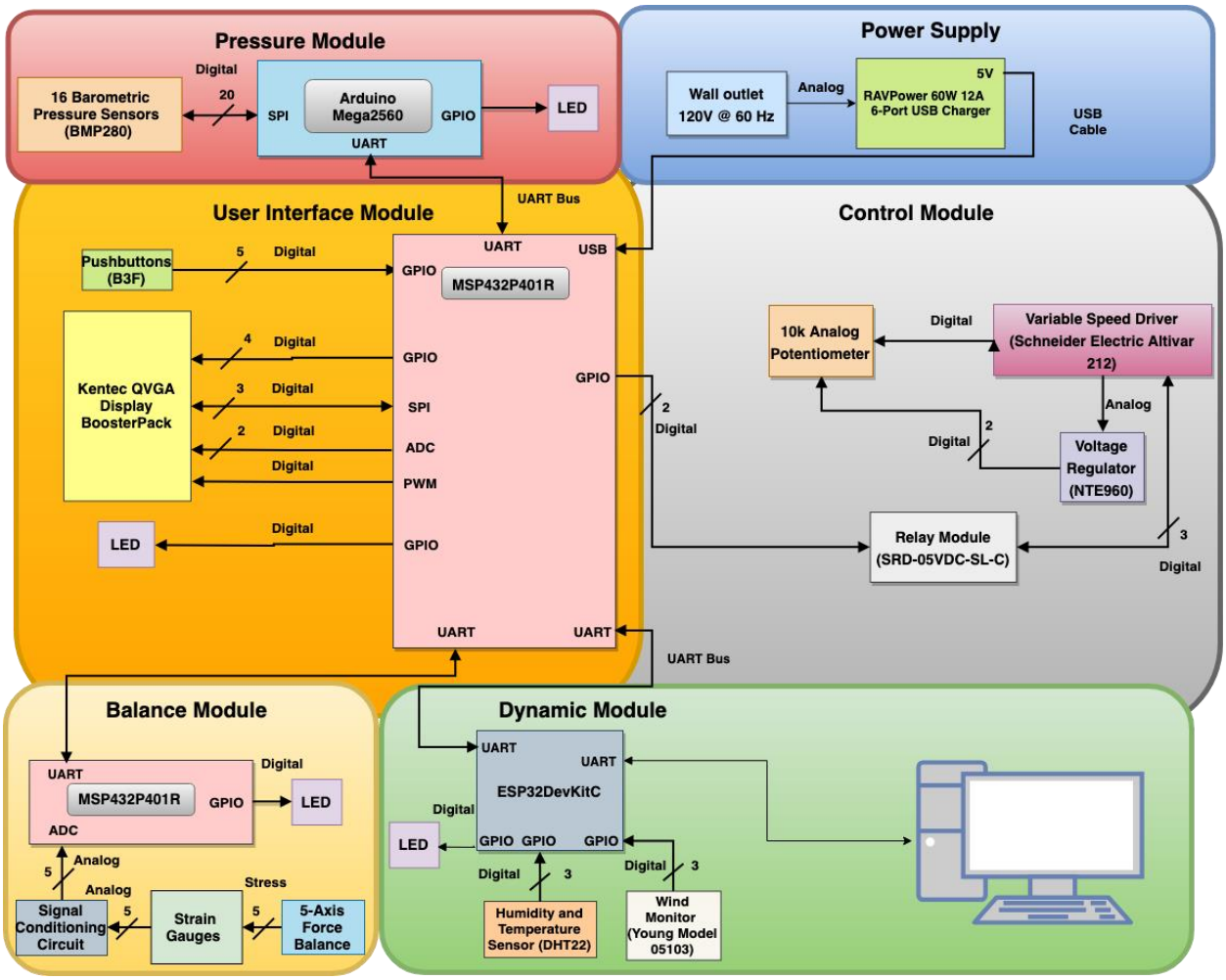


Fig. 1. WindTel Hardware Block Diagram

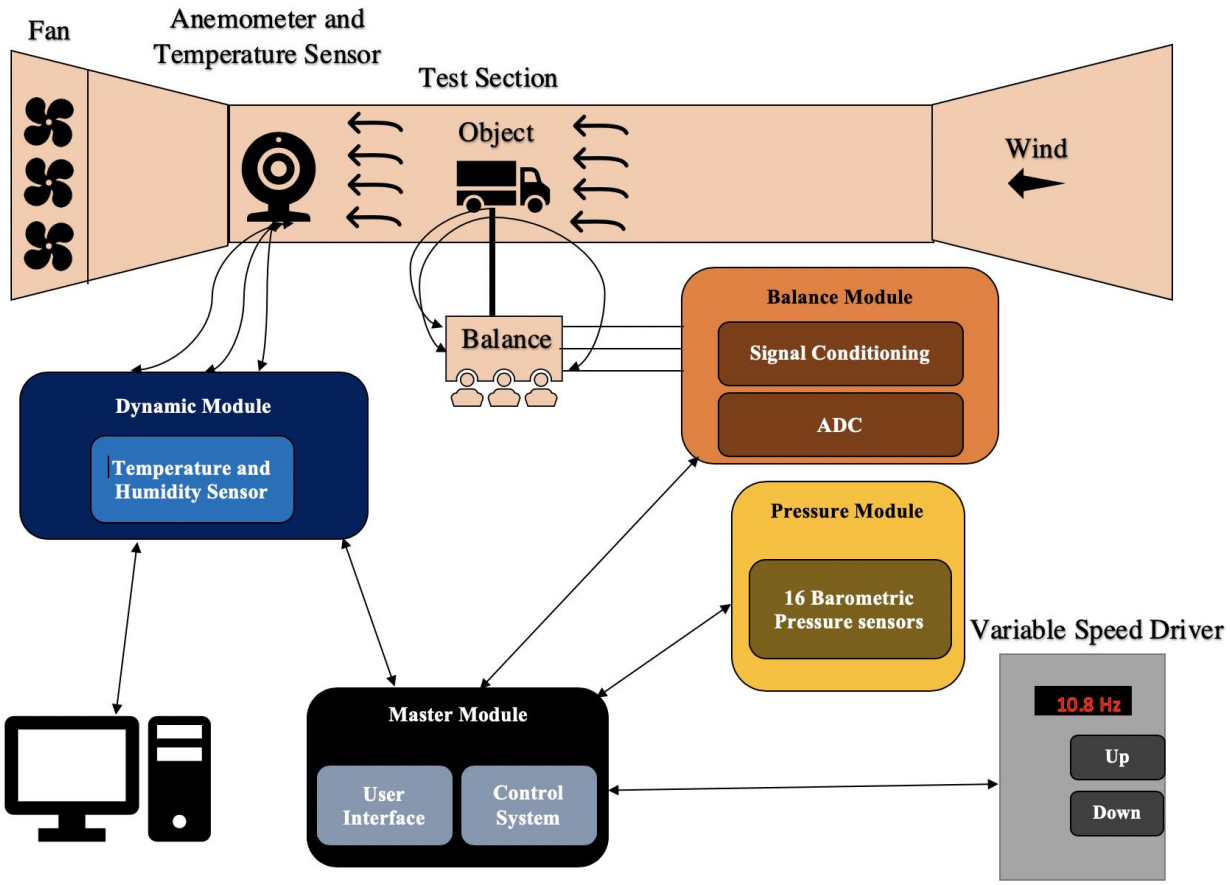


Fig. 2. WindTel System Conception Diagram

Master Module

The Master Module has the purpose of serving as an intermediary module, where the Balance, Pressure and Dynamic Measurements modules communicate with the Master Module via their own respective UART bus. The data acquisition process begins when the Master Module sends a request to a respective slave module. The Master Module is composed of a graphic Liquid Crystal Display (LCD), five push buttons and a relay module. Fig. 3 illustrate a block diagram of the Master module interfacing with its components.

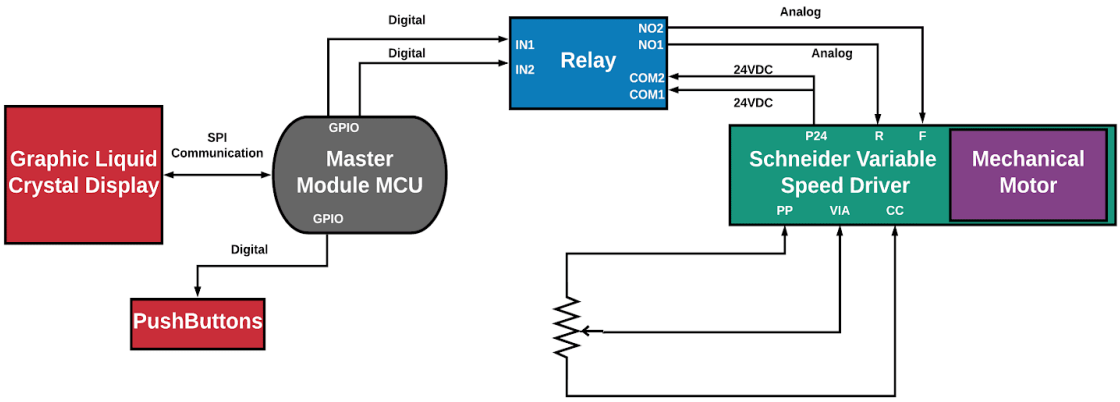


Fig. 3. Master module and its components

Control System

The control system component was implemented as part of the Embedded Systems Design course. Unfortunately, it did not satisfy the wind tunnel functionality. This control system was redesigned to use a 10k ohm analog potentiometer instead of a the proposed 10k ohm digital potentiometer. This redesign was performed due to the digital potentiometer getting damage due to incorrect power supply usage. A dual relay module is used to turn the wind tunnel operation on or off. The control system is interfaced via two General Purpose Input Output (GPIO) pins of the Master module microcontroller (MCU). The MCU sends two active low digital signals to the relay module IN1 and IN2 pins. The IN1 pin serve as a stop signal and IN2 serve has start signal to the variable speed driver the wind tunnel. The two-channel relay selection will indicate the wind motor direction. It is important to remove the default white pin header that the relay brings as defaults since its usage provides electrical/mechanical isolation. Fig 4 displays an image of the dual relay module with its removable header. Fig 5 displays an image of the Schneider Variable Speed Driver configuration and Fig. 6 display the timing diagram used for proper on/off functionality. The only signals used are F and R. Where R is first turn on and F performs a series of two consecutive digital pulses.

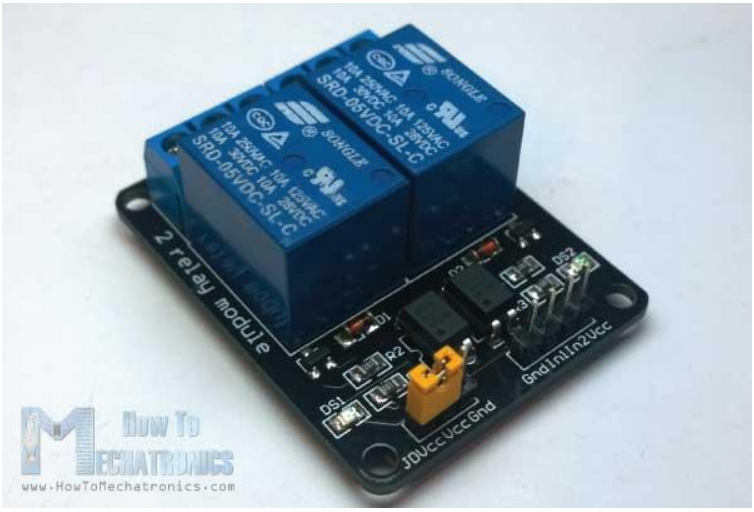


Fig. 4. Dual Relay Module

For more information regarding the dual relay module circuit diagram please refer to: https://howtomechatronics.com/tutorials/arduino/control-high-voltage-devices-arduino-relay-tutorial/.

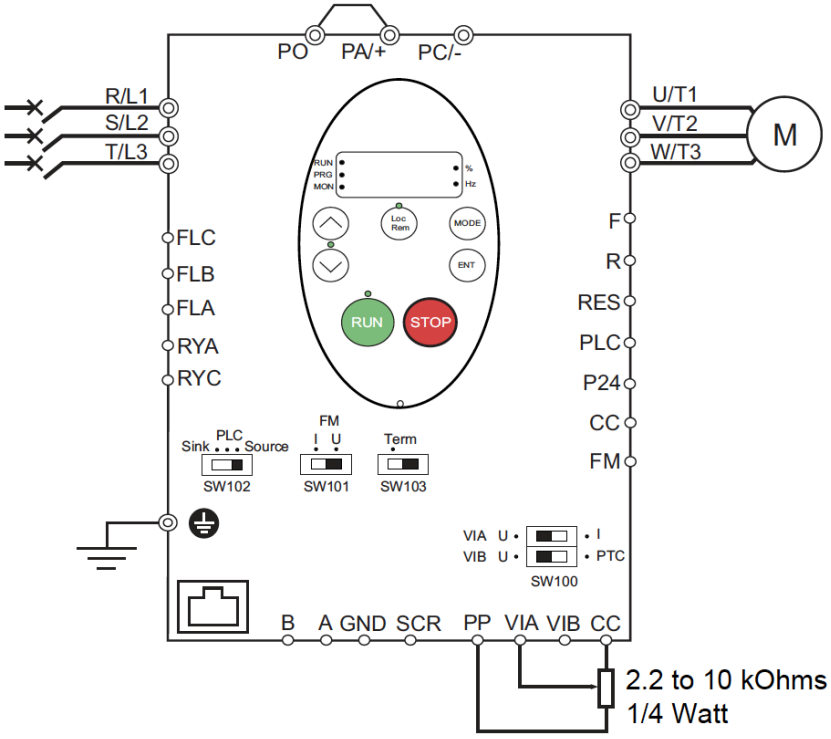


Fig. 5. Variable Speed Driver Configuration

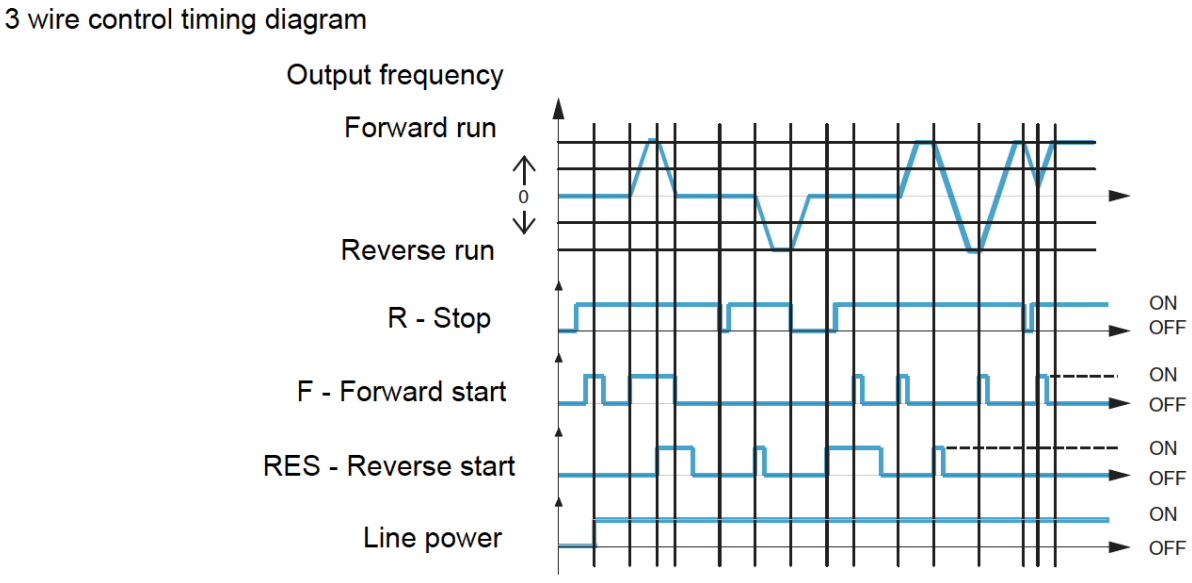


Fig. 6. Variable Speed Driver Timing Diagram

For more information regarding the Altivar 212 Schneider Variable Speed Driver please refer to its programming manual.

User Interface

The user interface as already being implemented as part of the Embedded System Design course. This component is composed of five hardware debouncing circuits and a graphic Liquid Crystal Display (LCD) BoosterPack named Kentec QVGA Display BoosterPack. Each of these circuit takes approximately 43.7ms to charge and approximately 39ms to discharge its respective capacitor. The time charge and discharge time values were chosen using has a guide the Embedded System Design Laboratory Manual. The LCD BoosterPack is a much simpler approach to implement due to the quick interface integration with the MCU. A TI hardware compatibility verification tool was used to determine the LCD and MSP432P401R compatibility. The LCD BoosterPack communicates directly with the MCU through SPI communication. TI provide an extensive library named DriverLib for BoosterPack source code development. Fig. 14 display the front view of the user interface.

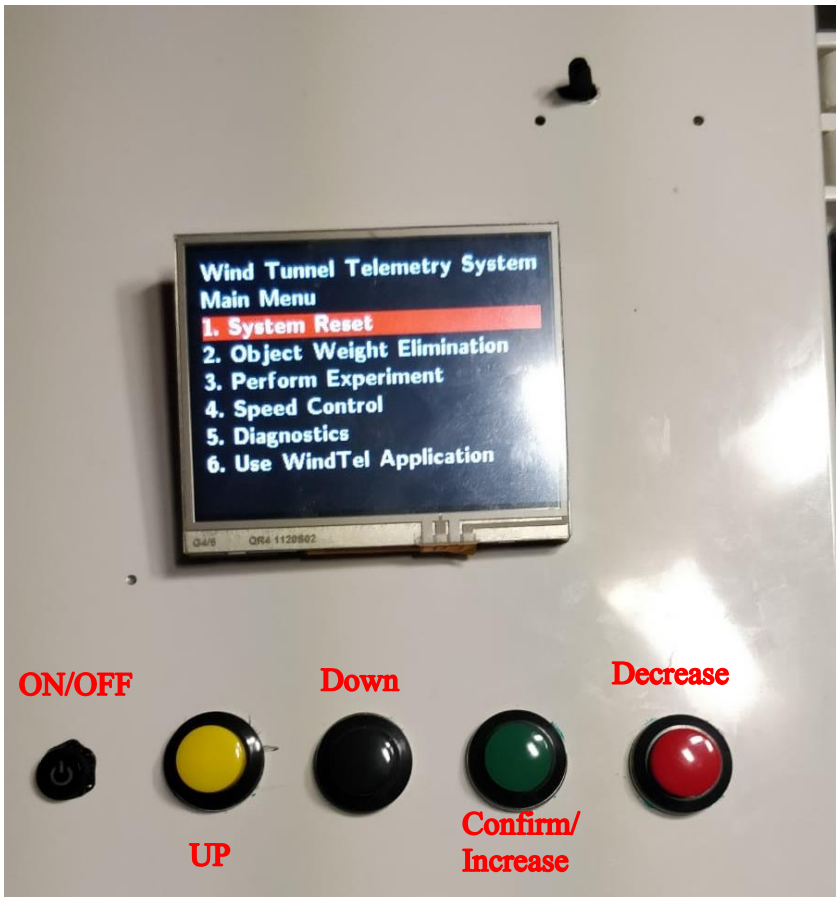
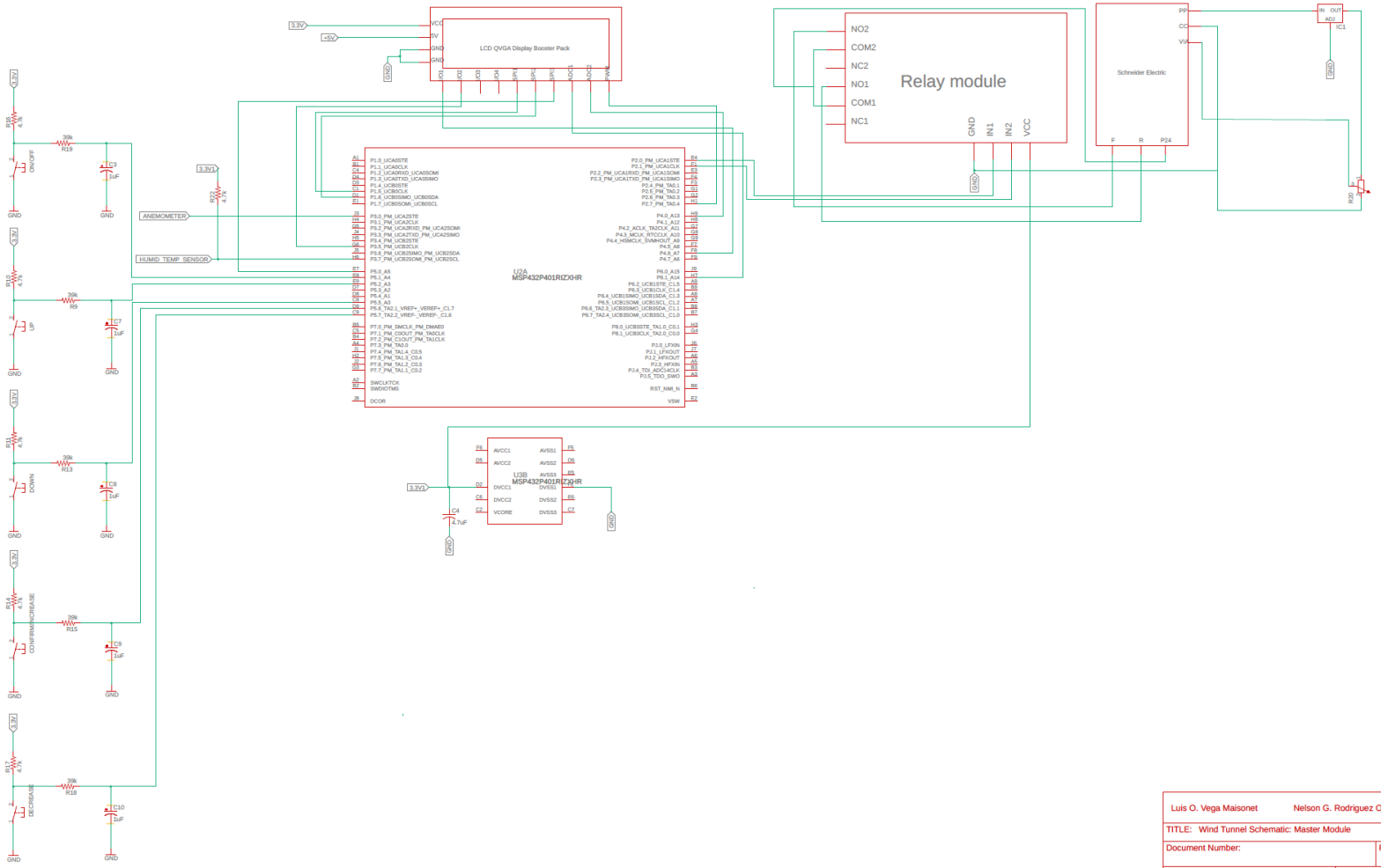


Fig. 14. Front Side of the User Interface Including the Analog Potentiometer in the Upper right corner of the enclosure

Master Module

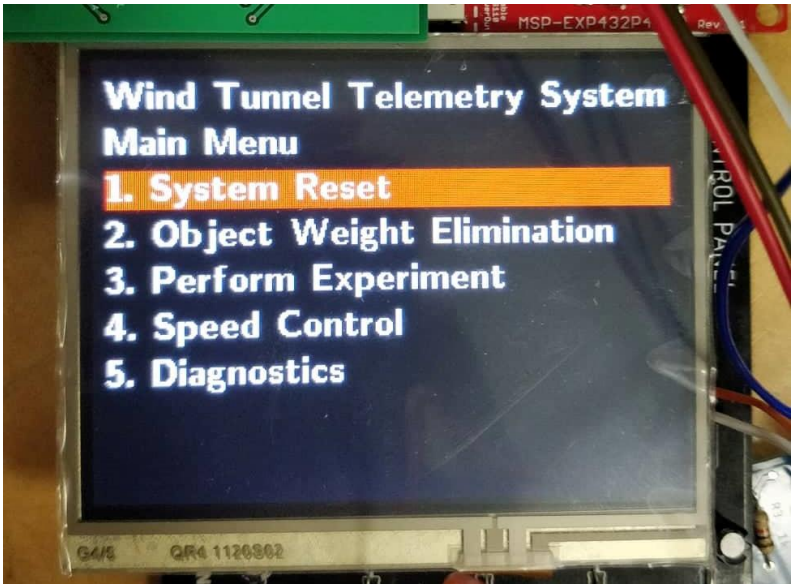


Luis O. Vega Maisonet	Nelson G. Rodriguez Ortiz
TITLE: Wind Tunnel Schematic: Master Module	
Document Number:	REV: 1
Date: March 1, 2019	Sheet:1/1

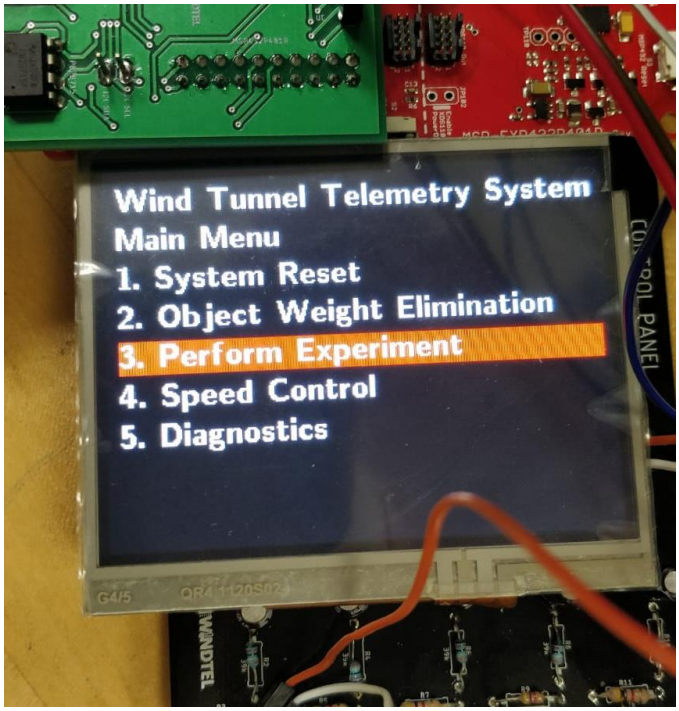
User Guide

Before proceeding with user's guide make sure the two wind tunnel chambers are open, the on/off laver is on and the start button is pushed. If the reader as any doubt of performing the mentioned task, please ask professor Raul Zapata Lopez for more information.

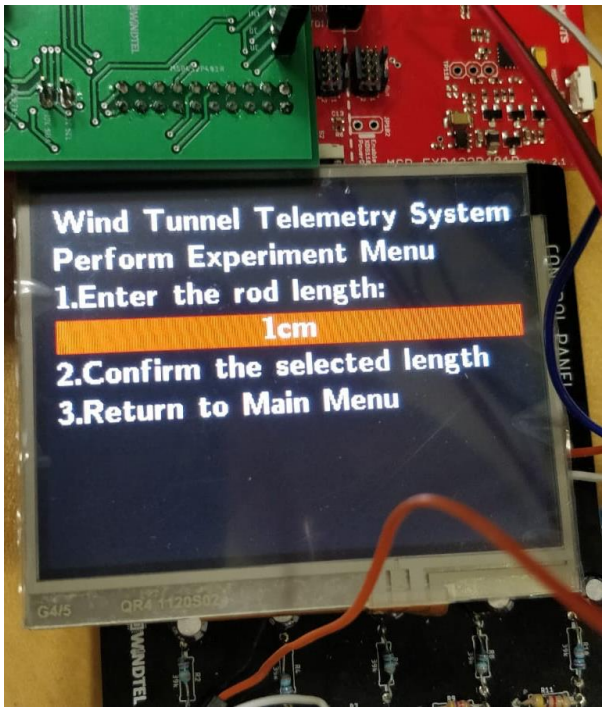
1. Connect the USB charger to the power outlet.
2. Turn on the WindTel System by pressing the ON/OFF button.
3. Select option number 3 from the Main Menu by using the Up and Down buttons to navigate and the Confirm/Increase button to proceed to the Speed Control Menu.
4. Press the Turn On the wind tunnel option.
5. Increase/decrease the speed of the wind tunnel fan by turning right or left the analog potentiometer in the enclosure. The wind speed will be display in real time in the LCD.
6. Select the Return to Main Menu option.



7. Move the red cursor by pressing the down button twice to select the Perform Experiment option.

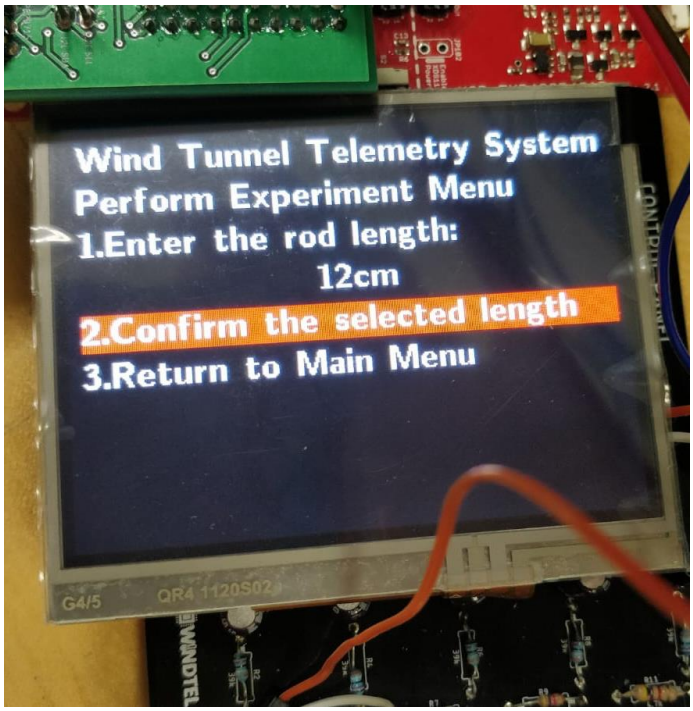


8. Press the Confirm/Increase button on the Perform Experiment option.

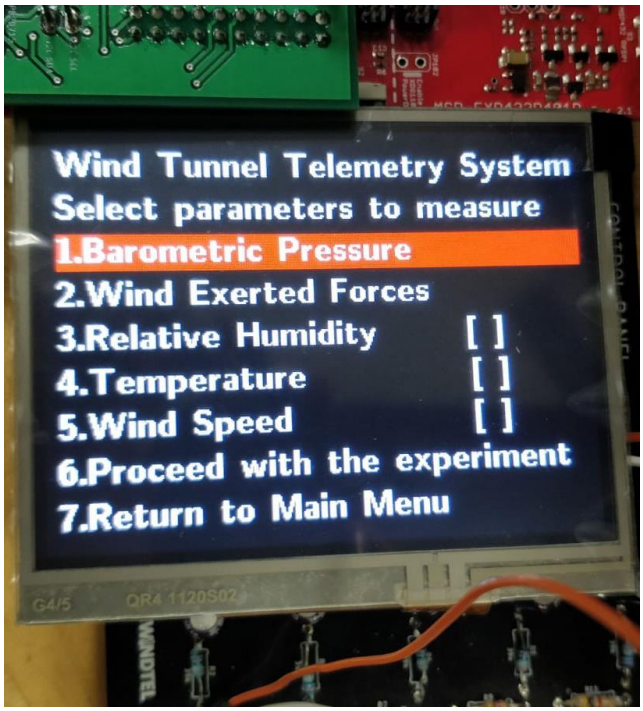


9. The user can increment the rod length number by pressing the Confirm/Increase button or decrement such number through the Decrease button. The limit of the rod length

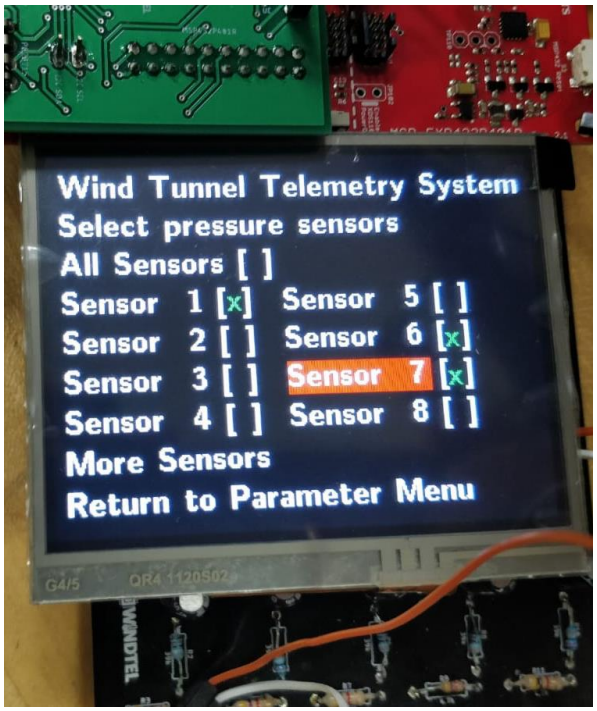
specification ranges from 1cm to 500cm. After selecting the desired length press the down button to select Confirm the selected length option and press the Confirm/Increase button.



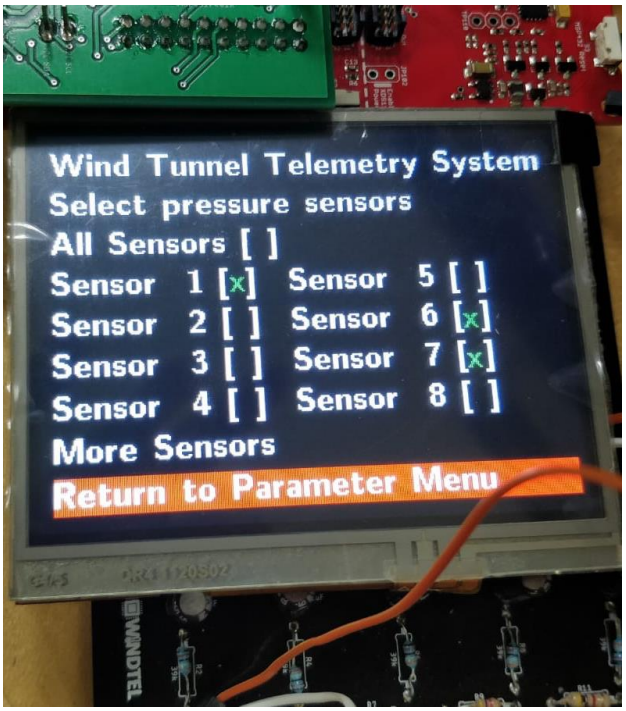
10. Select the desired parameters to measure by pressing the confirm button on option 1 to 5. Let's start by pressing the Confirm/Increase button on the Barometric Pressure button.



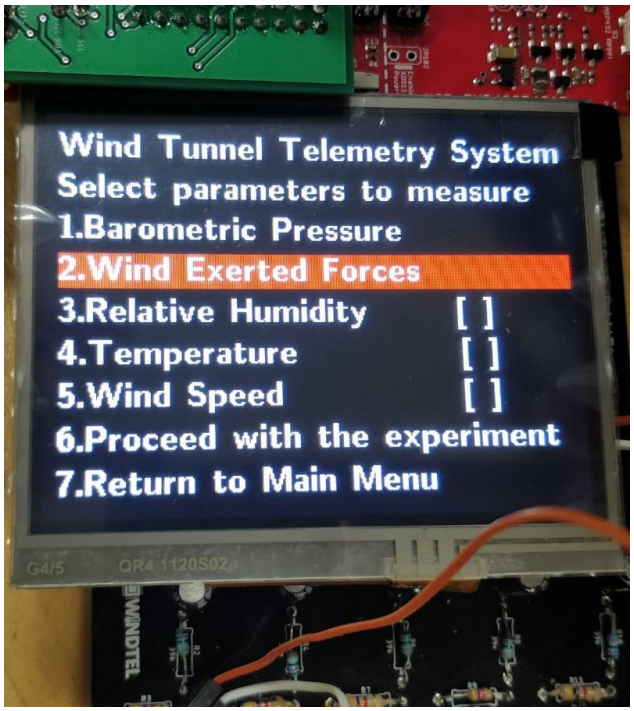
11. Select the pressure sensor number desired to acquire a measurement by pressing the Confirm/Increase button on the selected sensor and pressing the Down and Up button to navigate through the menu.



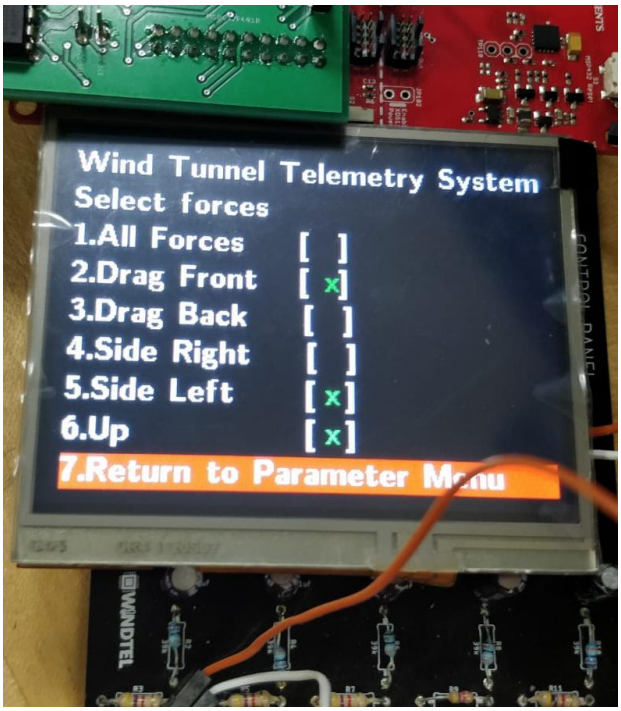
12. Select the Return to Parameter Menu option and press the Confirm/Increase button.



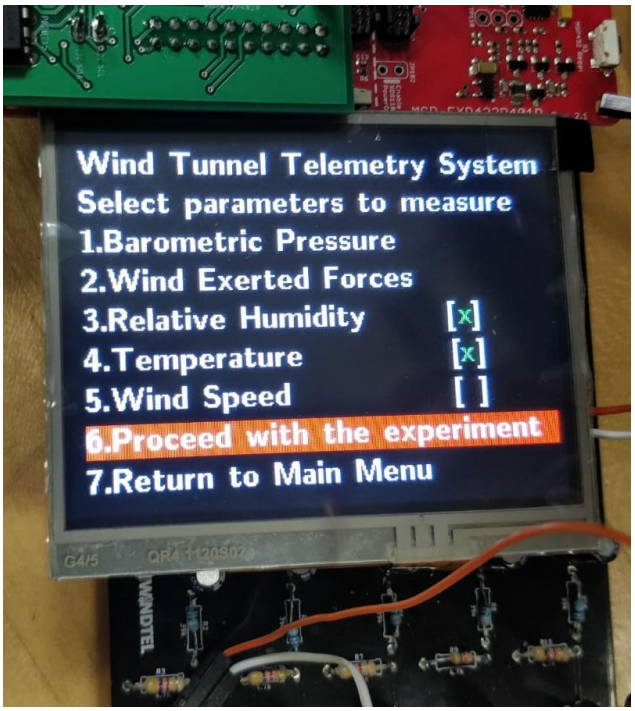
13. Press the Down button to select the Wind Exerted Forces option, press the Confirm/Increase afterwards.



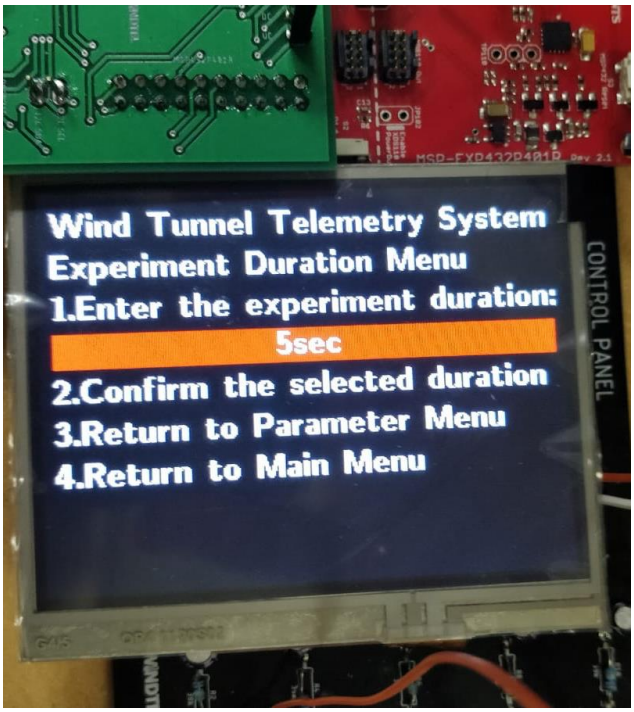
14. With the Up and Down button, navigate the wind exerted force parameters and select the desired wind exerted force parameters by pressing the Confirm/Increase button. Afterwards, select the Return to Parameter Menu option and press the Confirm/Increase button.

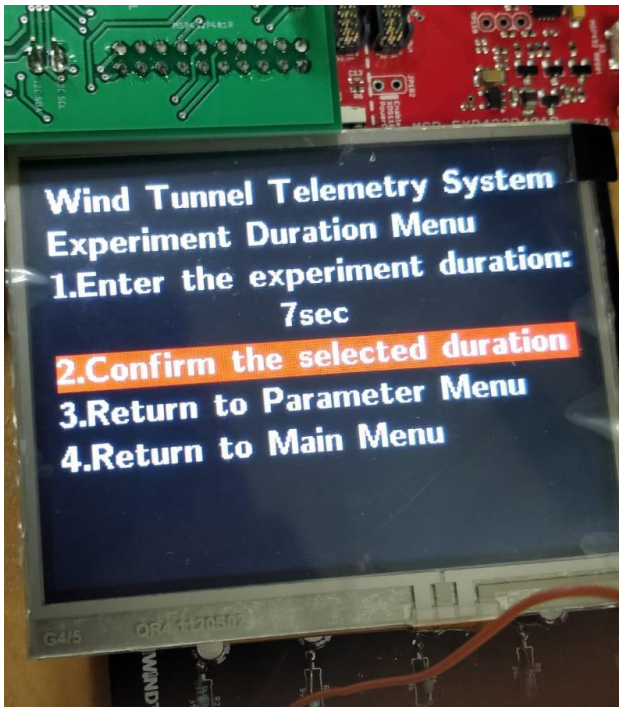


15. Select the rest of the desired parameters to measure by using the Up and Down button to navigate and pressing the Confirm/Increase button to select them. Select the Proceed the experiment option and press the Confirm/Increase button.

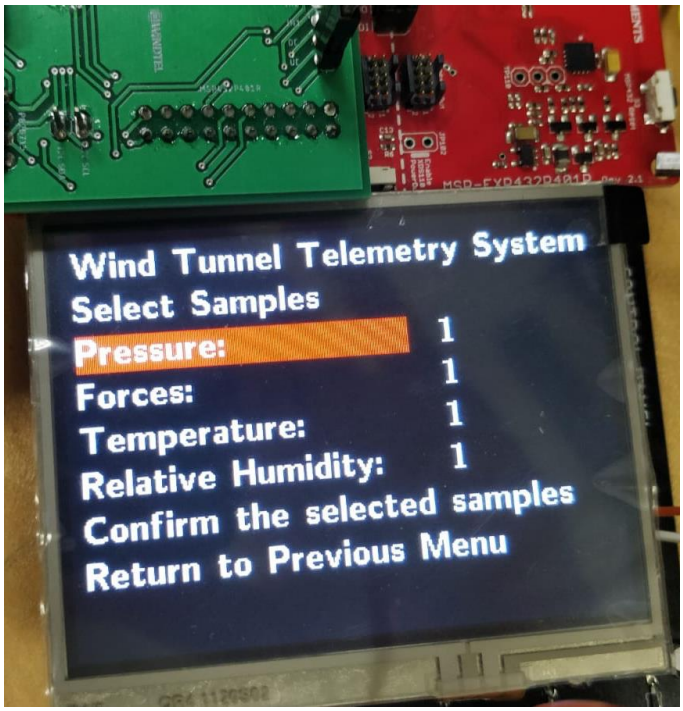


16. Increment or decrement the wind tunnel experiment duration by pressing the Confirm/Increase button and the Decrement button from 5 seconds to 5 minutes. After choosing the desired duration time select the Confirm the selected duration option by pressing the Down button and pressing the Confirm/Increment button.

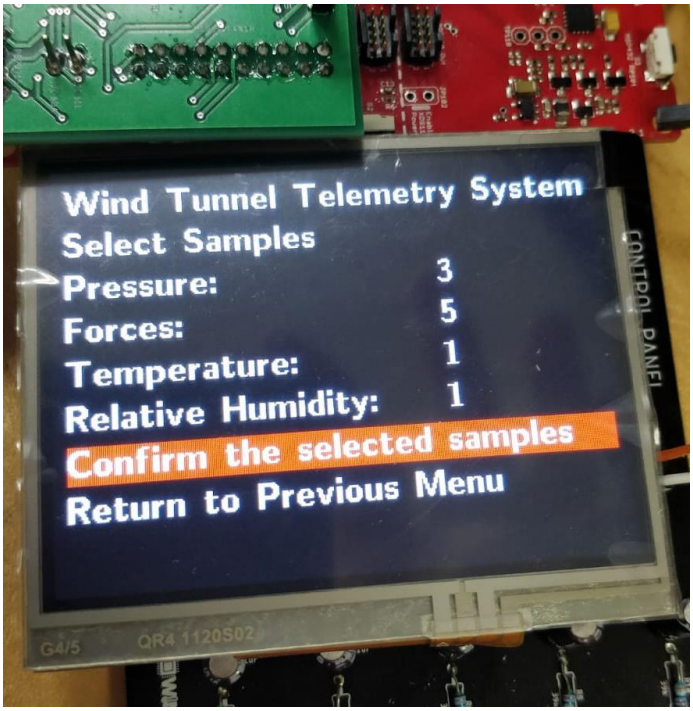




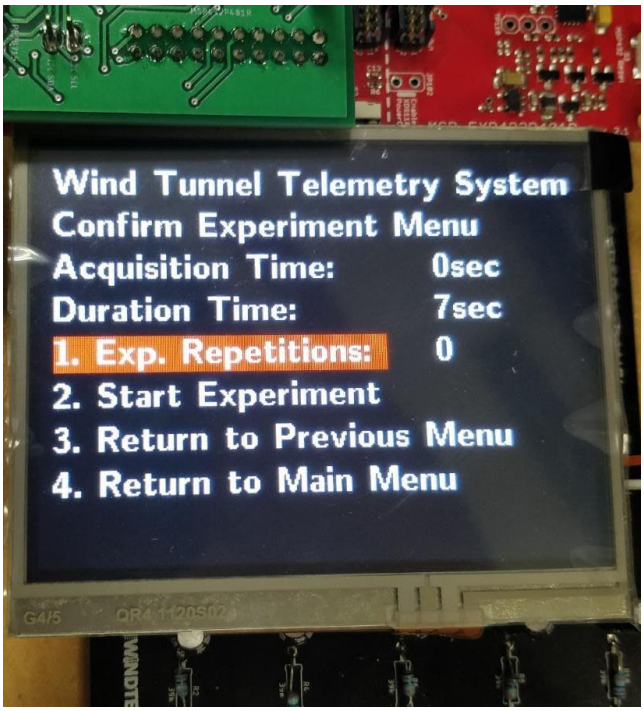
17. Select the number of samples to acquire during the experiment duration by navigating the menu by pressing the Up or Down button and increment or decrement the desire measurement sample using the Confirm/Increase button.

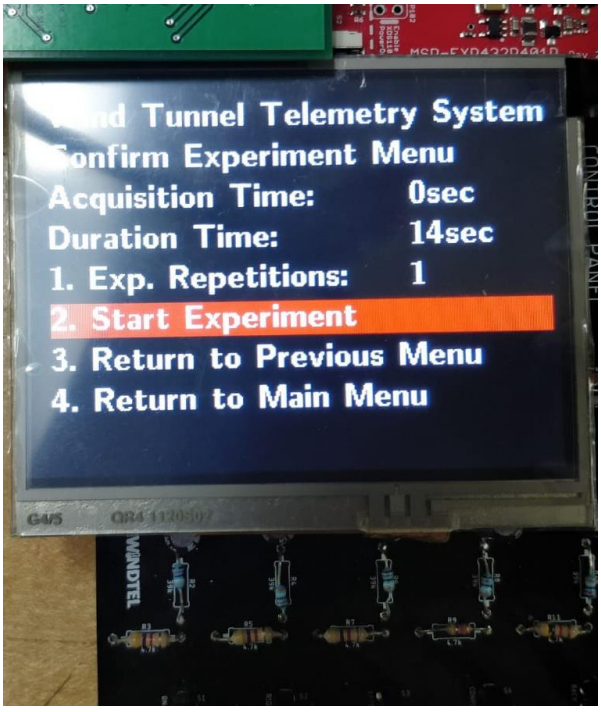


18. The Maximum number of samples is given by the data acquisition time of each independent sensor. For the pressure, force and wind speed measurements the sample size is directly proportional to the experiment duration time specified by the user. For each second of the experiment duration one sample can be taken from pressure, force and wind speed measurements. The relative humidity and temperature samples are limited to one sample every five seconds because the temperature and humidity sensor data acquisition time is 2 seconds. After selecting the samples, select the Confirm the selected samples option and pressed the Confirm/Increase button.



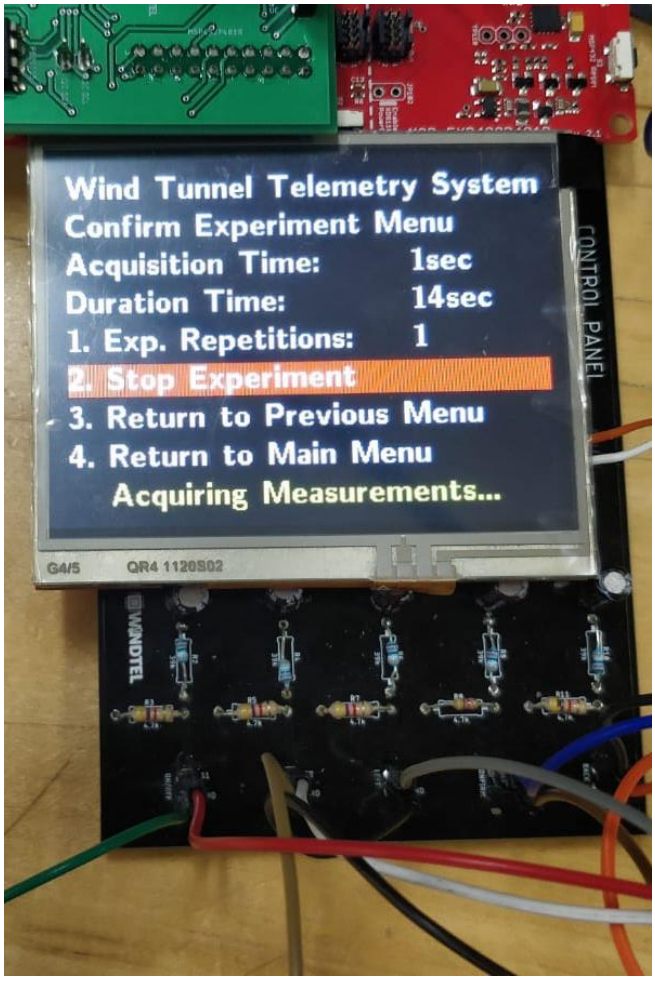
19. The user can manipulate this menu to acquire data measurements in specific time instances. To navigate this menu, press the Up or Down buttons and press the Confirm/Increase button to confirm an option. Wait until the experiment acquisition time reaches the experiment duration time.



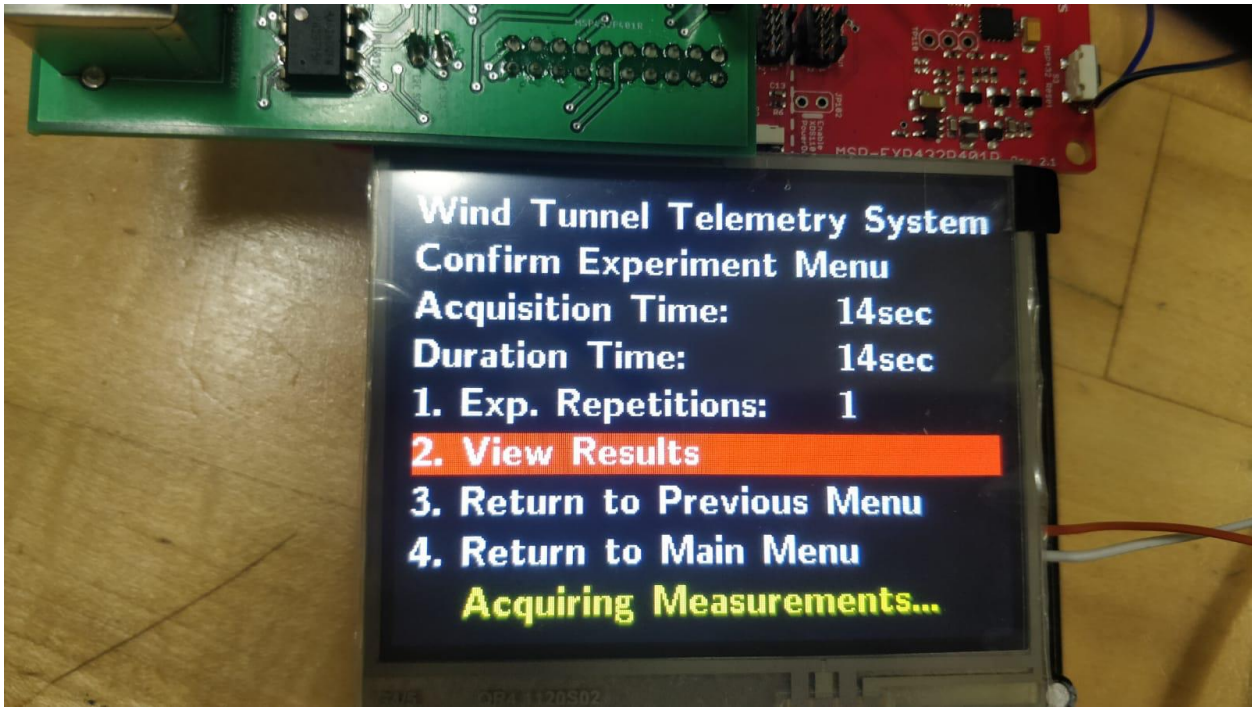


20. The LEDs of the Master, Balance Pressure modules should turn on a for a few seconds indicating that a module is communicating with other modules.

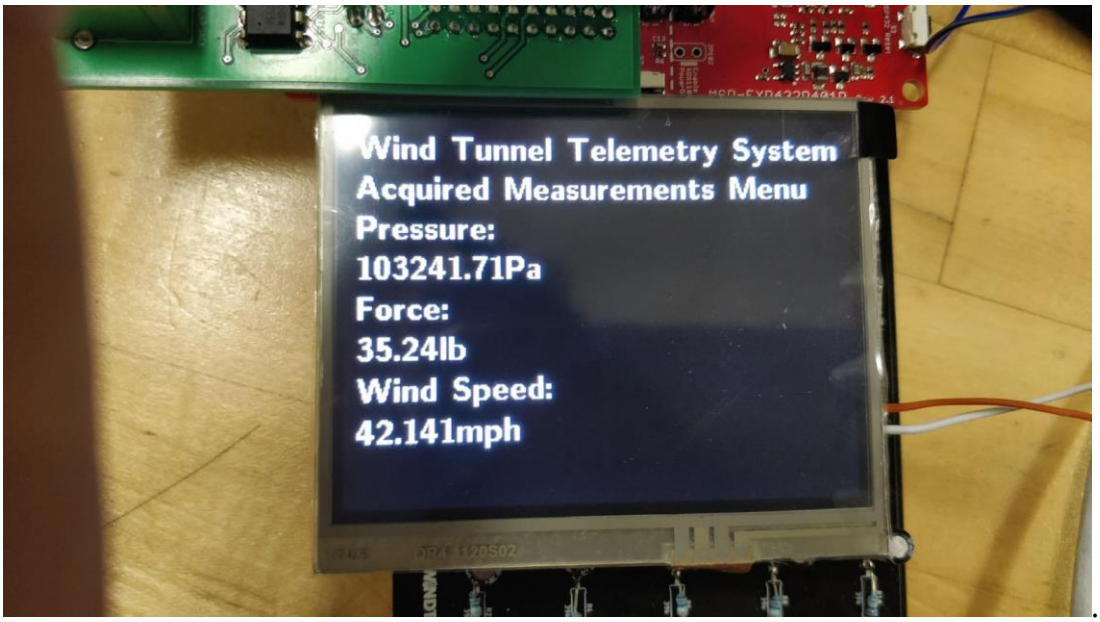
21. The experiment can be stop during the data acquisition process. A stop option will appear after the experiment starts. The user is limited to press the Confirm/Increase button during the experiment duration time.



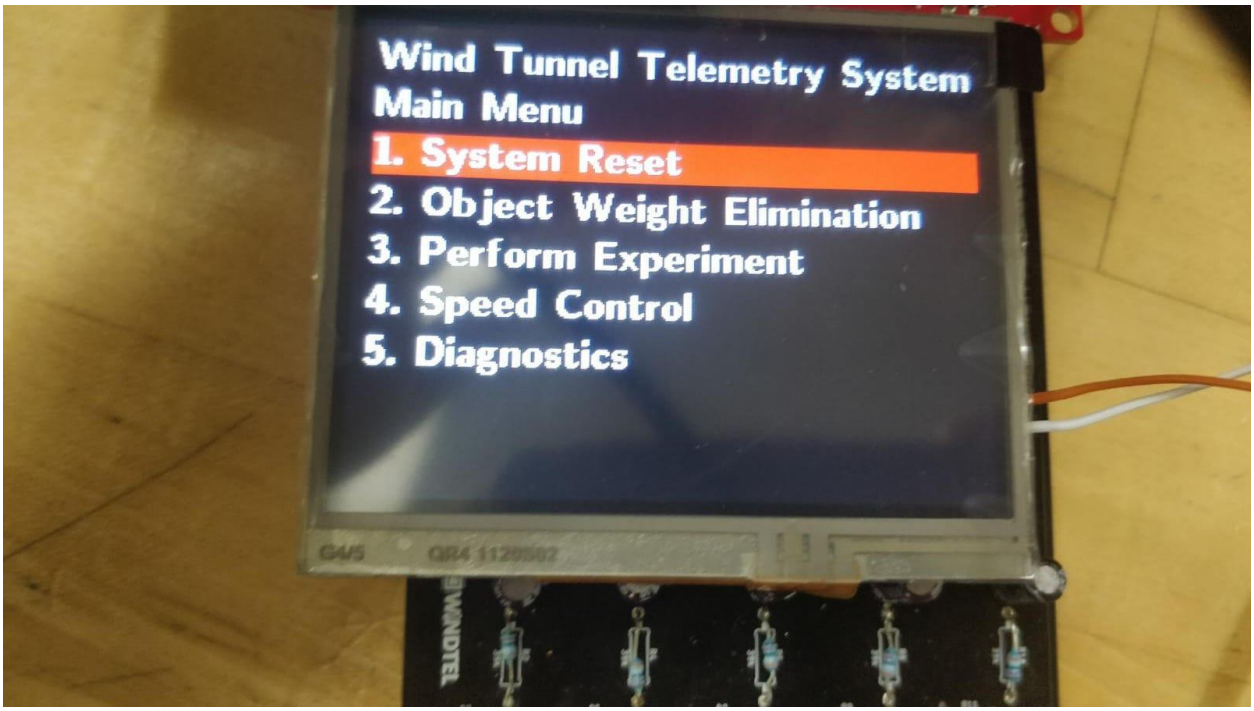
22. After the acquisition time reaches its limit a View Results option will appear on screen where the stop option was. The user is limited on pressing the Confirm/Increase option.



23. After the user press the Confirm/Increase option a new screen will appear showing the results acquired during the data acquisition process



24. The user is limited on pressing the Confirm/Increase option again. After pressing the button, the system transitions back to the Main Menu.


Wind Tunnel Telemetry System
Main Menu
1. System Reset
2. Object Weight Elimination
3. Perform Experiment
4. Speed Control
5. Diagnostics