Electrical Overview

Year: 2020 **Semester:** Fall **Team:** 6 **Project:** Snow-weAR Goggles
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Assignment Evaluation:

Item	Score (0-5)	Weight	Points	Notes
Assignment-Specific Items				
Electrical Overview		x3		
Electrical Considerations		x3		
Interface Considerations		x3		
System Block Diagram		x3		
Writing-Specific Items				
Spelling and Grammar		x2		
Formatting and Citations		x1		
Figures and Graphs		x2		
Technical Writing Style		x3		
Total Score				

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:
Relevant overall comments about the paper will be included here

1.0 Electrical Overview

The system includes six main components. The main processor is a 32-bit MCU+FCU microcontroller. It stores a display library and executable program code such as the main sequence and calculations needed to determine speed. The calculations are simple iterative algebraic calculations that use a combination of GPS data and accelerometer data to compute the skier's speed. The microcontroller receives acceleration and orientation information from the IMU and location data from the GPS. It also sends data to the GPS, initializing location sensing as well as determining the rate of sampling to preserve battery life. The battery is a rechargeable Lithium Ion Cell battery composed of round high capacity cells. [1]

The main processor also receives data from the coulomb counter, which reports State of Charge and End of Service, two metrics that allow for accurate battery life determination. This requires little to no processing by the main processor. The microcontroller will also have an interrupt set for receiving signals from the LoRa transceiver, requesting location information transmission. It can then send data back to the radio chip for transmission.

2.0 Electrical Considerations

2.1 Power budget

The main operating voltage of the device will be 3.3V. The chosen battery operates at 3.6V and is therefore capable of supplying the necessary voltage. Lower voltage components will be supplied through voltage regulators to keep them within their operating ranges and to minimize power consumption.

Device	**uC**	**IMU**	**GPS**	**LoRa Transceiver**	**OLED Display**	**Coulomb Counter**
Operating Voltage	3.3V	3.3V	3.3V	1.8V	3.3V	2.7V
Current Draw	140mA	12.3mA	14mA	12mA	200mA	.133mA
Power consumptio n	462mW	41mW	25mW	21mW	660mW	.36mW

The total power consumption is approximately 1.21 Watts per hour . Because the system needs to run for 5 hours according to the functional specification, 6.05 Watt hours is required. The voltage level of the battery affects the conversion to Amp hours. Most lithium-ion batteries operate at 3.6 Volts [2], so a 1.68 Amp hour cell is required.

Additionally, expected current draw at any given time can not exceed the maximum discharge current of the battery. Most batteries have a discharge current of 1C or less. The system application is under this amount at about .38C. The battery selected has a maximum discharge current of 1C, a 3.7V supply, and 2600mAh capacity. This is able to supply the system.

2.2 Tolerances

All current supplied to the system must pass through the Coulomb Counter and therefore must adhere to its maximum input rating. This is 32 Ah, 32A or 65V. The device is well within that range.

Device	**uC**	**IMU**	**GPS**	**LoRa Transceiver**	**OLED Display**	**Coulomb Counter**
Voltage Supply Range	.3 to 4.3V	.3 to 3.6V	.3 to 4.3V	-.5 to 3.9V	-.3 to 4V	-.3 to 5.5V
Max Current	140 mA	12.3 mA	400 mA	1.8 mA (standby mode)	34.3 mA	250 mA

With a 3.7 Volt battery, the voltage limits are not a big concern. Although many such batteries can charge higher than the nominal voltage, a voltage regulating circuit can be used.

2.3 Operating Frequency

The component that requires the highest operating frequency in the system is the OLED display. The other components can afford to have transmit and sample rates on the order of 2 Hz or less in order for accurate and timely reporting. The display is an LED interface that requires a fast enough refresh rate to eliminate the perception of blinking on the user end.

The update interval should be less than 10 ms for the user experience. This means that the data bits leaving the controller (around 8 kB) would have to leave at a rate of at least 6 Hz, which is a data rate of 48 kHz.

3.0 Interface Considerations

The design uses primarily SPI and I2C to interface between components. Two different I2C interfaces will be connected to the main processor, one for the Inertial Measurement Unit and the other for the Coulomb counter. An SPI bus will be used to communicate between the GPS, the LoRa Transceiver, and the TOLED Display with the primary microcontroller. This will require a clock line, a master in/slave out line, a master out/slave in line, and three slave select lines, one per each sensor/interface. A GPIO pin will provide an interrupt source for the main processor in the event that a transmission is received from the radio chip.

4.0 Sources Cited:

[1] "Lithium Ion Battery - 18650 Cell (2600mAh)," *PRT-12895 - SparkFun Electronics*. [Online]. Available: https://www.sparkfun.com/products/12895. [Accessed: 15-Sep-2020].

[2] "BU-303: Confusion with Voltages," *Battery Voltage Information – Battery University*. [Online]. Available: https://batteryuniversity.com/learn/article/confusion_with_voltages. [Accessed: 15-Sep-2020].

Appendix 1: System Block Diagram