

Small, Lightweight Speed and Distance Sensor for Skiers/Snowboarders

Air Force Research Laboratory
Design Team 5
Progress Report

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Summary:

Our team progress has been moving steadily over the past couple of weeks. The first prototype has been completed, and now pending more test trials, the team will be building the second prototype. We have so far accomplished quite a bit. The Doppler module signal output is being properly processed to give a linear relationship between the frequency deviation (Doppler shift) and output voltage. The circuitry tasked with performing this conversion was relatively easy to design and was working within a couple hours of prototyping.

The LCD display, our means of communication with the user, is now fully integrated with the microcontroller. We have created libraries with many functions for easy programming of the LCD display. We have also started developing classes for menu navigation. As a placeholder for the menu system, the device currently displays the instantaneous velocity of the speedometer with display refresh toggled by a single user input.

The system is currently powered by pairing a 9 volt battery with a 5V voltage regulator; at this point in development the device has an unknown current capacity. Tests in the following weeks will allow us to determine whether a more advanced battery is necessary for the project.

Our current short term goal is to begin implementing persistent memory storage and also calibrate the velocity detection of the device. Afterwards, key features like average speed, distance calculation, and power management will be coded in software. After the second prototype has been built we plan to begin PCB layout for the speedometer as well as enclosure design.

LCD Screen: We have made good progress with the LCD display; under load it draws nearly 10 mA of current. Ben Guild has been able implement functions to make output to the LCD easier. The team has also programmed the LCD to correctly display the value of the A/D Converter. The LCD can also display dummy menus, with navigation control by user input from the microcontroller. The current goal is to finish designing our menu layout, and creating a class system which handles display output and menu navigation. These tasks are currently assigned to Tim Ross and Temika Cage.

Doppler Module: Work with the Doppler module is almost entirely complete. The Doppler signal processing circuitry is currently connected to the ADC pin of the microcontroller. We are able to convert the ADC voltage value to a velocity for recording. In practice, we have found that the Doppler module accurately reports change in velocity linearly with the changing frequency of the Doppler signal. All components of the Doppler system use a single battery source, including the single-supply op-amp. Further testing is required to fine tune the signal for various speed ranges, the current frequency to voltage converter can only detect speeds from 0 – 24 mph. A second frequency to voltage converter may be necessary to detect other velocity ranges. Kunal Verma and Justin Erskine will continue to modify the Doppler system as the project continues.

Voltage Regulator: Originally the team planned to use an LM317 adjustable voltage regulator for the project, but decided to pass up the option for a simpler, one component design. The nominal output of the current voltage regulator is $4.993 \pm .002$ V. This is the full range for both a fully charged and depleted battery. Justin Erskine was tasked with designing the power system.

Budget:

Cost Breakdown				
Item	Part Number	Manufacturer	MSRP	Cost
Microcontroller	PIC18F4520	Microchip Technology	\$4.15	\$0.00
LCD Display	TM162AAA6-1	Tianma Microelectronics	\$37.00	\$0.00
Radar Module	HB100	AgilSense	\$15.00	\$15.00
Op-Amp	LF347N	National Semiconductor	\$0.96	\$0.00
Freq/Voltage Converter	LM2907N	National Semiconductor	\$2.02	\$2.02
Battery	PC1604	Duracell	\$10.00	\$0.00
Voltage Regulator	LM7805C	National Semiconductor	\$1.25	\$0.00
Total Cost			\$70.38	\$17.02