CANSense

ECE499 — Design Project II,

University of Victoria

Group 3:
Solomon Lindsay, Malcolm Grahame,
Trevor Ford, Nathan Green

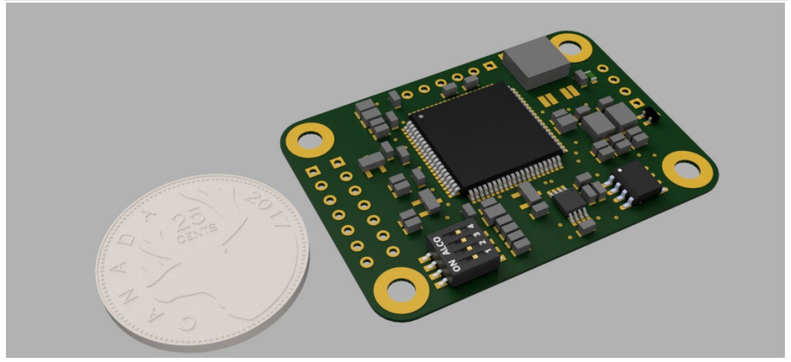
Introduction

The UVIC SAE Formula Electric team is building an electric vehicle for their competition. This vehicle will have several auxiliary sensors such as acoustic sensors, infrared temperature sensors, thermocouple temperature sensors, and strain gauges that will collect data for analysis. Dedicated hardware is required to interface the sensor outputs with the CAN bus on the electric vehicle.

Project Goals

The goal of the project is to develop a piece of hardware that can be used to connect sensors to a CAN bus on a formula style race car. It is important that this device is designed to be configurable so that the same hardware can be used with the wide variety of sensors required onboard the vehicle.

PCB Design



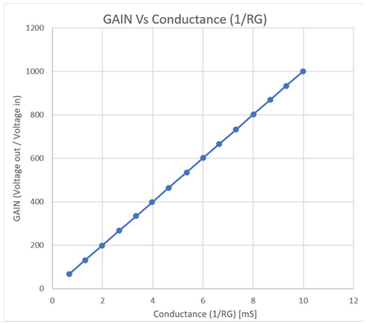
Principle Design Goals: The main design goal of the PCB was to minimize the overall rigid size of the device as much as possible. This was accomplished through several iterations of redesign, with each iteration optimizing component placement and trace routing to further decrease the size of the device. This process, combined with an early design decision to utilize a 4-layer PCB and incorporate "flying leads" rather than onboard connectors reduced the size of the PCB to approximately 5cm x 3 cm which is comparable in size to a couple of quarters. The secondary goal of the PCB design was to incorporate multiple communication interfaces such as SPI, I2C, UART, and both analog and digital I/O to allow the formula SAE team flexibility in firmware development and adding additional sensor options to the vehicle without having to redesign the hardware.

Component Selection

Microcontroller: The microcontroller is the processing center of the CANSense module so it was vitally important. It was decided to use the 8-bit STM8AF6269TAY automotive microcontroller due to its low cost, small size, and ample interface capabilities. [1]

Power Supply: As a module device on the FSAE electric formula car, the CANSense module had to be designed to run off the vehicle batteries. In addition the module had to regulate power for an array of sensors. It was concluded that two linear regulators would be used to minimize noise for sensor performance and to provide 3.3V and 5V supplies to satisfy any sensor requirements.

Strain Gauge: The strain gauge sensors were identified as one of the most important sensors for the CANSense module to read and was selected as a primary requirement. Strain gauge measurements have quite fine voltage ranges that change depending on the setup of the gauge. In order for a 10 bit 3.3V ADC to read fine voltage changes a variable gain amplifier was required [2]. The gain of the amplifier will be adjustable using a set of DIP switches to provide the gain range shown in the graph to the right.



CAN Transceiver: The CAN transceiver is necessary to allow the CANSense module to send sensor data along the CAN bus to where the vehicle's central computer can log it. [3]

Firmware

Discovery Boards: Using the STM8A Discovery kit to develop code for the CANSense module [4]. This kit has an STM8AF588 microcontroller which is nearly identical to the one being used on the final CANSense module which allows for developing and testing code while the board was still being designed.

Development Environment: Using ST Visual Develop with Cosmic compiler to develop, compile, and debug stm8 code in c language.

Programming: Using ST Visual Programmer to flash assembly code onto the boards using SWIM (Single Wire Interface Module)

Results

Due to loss of the PCB during shipping and challenges with the firmware development environment, the project did not get to a stage where testing of a prototype could be completed; however, a test plan was designed for when the board can be assembled and programmed. Some preliminary validation was able to be done on the development boards to ensure the firmware would be capable of meeting specifications for future tests, but the majority of testing is delayed until the hardware can be assembled.

Future Work

Future work will be continued by the members of this group and the FSAE team as the CANSense module will be a useful addition to the UVic formula car. While a substantial amount of progress was made during this project course, the final assembly and testing still must be done once the hardware can be delivered. Testing will likely lead to new challenges that will require debugging and prototyping. This CANSense module is the first prototype so any number of changes could be made as the project progresses.

References

[1] Digi-Key, "STM8AF6269TAY," [Online]. Available: https://www.digikey.ca/en/products/detail/ stmicroelectronics/STM8AF6269TAY/3087851. [Accessed 06 2021].

[2] Phidgets inc., "Full-bridge Steel Strain Gauge (Bag of 2)," 2016. [Online]. Available: https://www.phidgets.com/?tier=3&catid=9&pcid=7&prodid=237.

[3] yida, "Introduction to CAN-BUS and How to use it with Arduino," 2019. [Online]. Available: https://www.seeedstudio.com/blog/2019/11/27/introduction-to-can-bus-and-how-to-use-it-with-arduino/. [Accessed July 2021].

[4] ST, "STM8A-Discovery Data brief. Doc ID 023712 Rev 1," Nov 2012. [Online]. Available: https://www.st.com/en/evaluation-tools/ stm8a-

Acknowledgements

Thank you to the SAE Formula Electric team for providing technical guidance and partial funding for our project. More specifically thank you to Peter Touchinski for his input on the details related to the sensors and CAN bus. Thank you to Charlie Plaskasovitis for giving the group input & help throughout the project. A special thank you to SAE Formula Electric team lead Trevor Ford for pitching the project idea and for joining our team. Thank you to Ilamparithi for graciously serving as the project supervisor and provide the team with valuable input.