SDM-23 Data Acquisition Package

Design Report

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Abstract

The SDM-23 Data Acquisition (DAQ) package provides data logging and analysis capabilities for SDM-23, Sun Devil Motorsports' challenger for the Formula SAE Michigan 2023 ICE Competition. It was designed and implemented over the course of the 2022-23 school year.

This report details the goals, design, and implementation of the DAQ package. The design approach, methodologies, and procedures used by the DAQ subteam are also included in the report. Finally, the results of implementation and testing are documented along with recommendations for future work and designs.

1 Introduction

1.1 Project Goals

1.2 Project Justification

2 Background

The purpose of this chapter is to explain concepts and sensors referenced later in the report, and to describe the functionality of the sensors and hardware used in the DAQ package. An overview of known previous DAQ packages and iterations developed by Sun Devil Motorsports have also been included.

2.1 Previous Designs

2.1.1 SDM-20/21

2.1.2 SDM-22

This was the Data Acquisition team's first attempt at a permanent DAQ system.

2.2 Selected Components

The components discussed in this section are the sensors and other hardware that have been included in the DAQ package for SDM-23.

2.2.1 Teensy 4.1

The DAQ package requires sensor processing and communication standards to reliably collect and log data from the vehicle. The Teensy 4.1 seen in Figure 2.1 is a ARM Cortex-M7 based development board with an NXP iMXRT1062 chip operating at 600 MHz. Notably it comes with a built-in SD socket, 3 CAN controllers, 3 I2C and 8 Serial ports and 18 analog input pins among many other features. This makes it a great option to use as the main data logger.

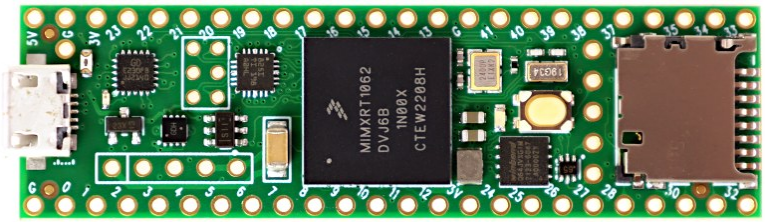

Figure 2.1: Teensy 4.1 Microcontroller

2.2.2 Teensy 4.0

The Teensy 4.0 (Figure 2.2) has the same processing specs as the Teensy 4.1, but in a smaller form factor. As such, there is less accessible GPIO pins available and no built-in SD socket. With that said, it still has 7 Serial and 3 I2C ports, 3 CAN controllers, and 14 analog input pins, though some are not easily accessible.

Its smaller form factor makes it a good choice for smaller data hubs that can be placed around the car.

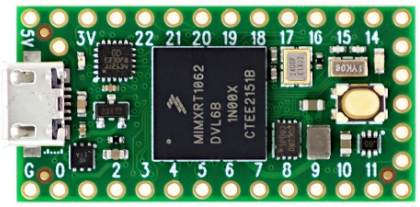

Figure 2.2: Teensy 4.0 Microcontroller

2.2.3 SN65HVD230

CAN bus hehe xd

2.2.4 Linear Potentiometer

Potentiometers are three-terminal resistors with a sliding or rotating contact that form an adjustable voltage divider. Linear potentiometers are mounted to the dampers on SDM-23's suspension in order to measure the damper travel.

2.2.5 Rotary Potentiometer

A rotary potentiometer is attached at the pinion gear of the steering rack to measure the steering wheel angle. The model used is

2.2.6 3-Axis Accelerometer

2.2.7 Pressure Transducer

2.2.8 Brake Temperature Sensor

2.2.9 Strain Gauge

2.2.10 GPS Module

A GPS module is used

3 Methodology

3.1 Timeline

3.2 Hardware Design

The design of the DAQ package required hardware in the form of printed circuit boards (PCBs), wiring, enclosures, and sensor mounts.

3.3 Software Design

The software component of the DAQ package consists of embedded software written in C++ for the Teensy microcontrollers with the Arduino library and Python GUI software using the PyQt5 and pyqtgraph libraries.

3.4 Testing and Integration

4 Engineering Design

4.1 DAQ Design Overview

5 Results

5.1 SDM 21.5 Validation

6 Conclusion and Future Work