Sukup Temperature Device Tester

Design Document

Sddec24-04
Client: Dana Conrad - Sukup
Advisor: Dr. Nathan Neihart
Team Members: Justin Garden, Tony Haberkorn, Sam Estrada, Michael Hurley
Email: sddec24-04@iastate.edu
Website: sddec24-04.sd.ece.iastate.edu

Executive Summary

Development Standards & Practices Used

- Standard Reference Designations for Electrical and Electronics Parts and Equipments (IEEE Std 200-1978)
- Standard For Test Code for Resistance Measurement (IEEE Std 118-1978)

Summary of Requirements

Functional:

- Measure accuracy of measurement chip (MAX31865)
- Simulate controllable RTD resistance
- Test fault conditions
- RS485 Compatible
- Test Modbus communication
- Send test results to computer
- Run specific tests separately or sweep all tests

Physical:

- Compatible with standard wall outlet
- Compatible with standard USB-A connecter
- Desktop sized
- Buttons for user to select test

UI:

- LCD display
- Display current test
- Display test results

Applicable Courses from Iowa State University Curriculum

- EE 1850: Introduction to Electrical Engineering and Problem-Solving I
- EE 2300: Electronic Circuits and Systems
- CprE 288 - Embedded Systems

New Skills/Knowledge acquired that was not taught in courses

- PCB Design
- Python coding language
- Voltage regulator
- Microcontroller part selections

Table of Contents

1. Introduction 6
  1.1. Problem Statement 6
  1.2. Intended Users 6
2. Requirements, Constraints, And Standards 7
  2.1. Requirements & Constraints 7
  2.2. Engineering Standards 7
3 Project Plan 7
  3.1 Project Management/Tracking Procedures 7
  3.2 Task Decomposition 7
  3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria 8
  3.4 Project Timeline/Schedule 8
  3.5 Risks And Risk Management/Mitigation 9
  3.6 Personnel Effort Requirements 9
  3.7 Other Resource Requirements 9
4 Design 10
  4.1 Design Context 10
  4.1.1 Broader Context 10
  4.1.2 Prior Work/Solutions 10
  4.1.3 Technical Complexity 11
  4.2 Design Exploration 11
  4.2.1 Design Decisions 11
  4.2.2 Ideation 12
  4.2.3 Decision-Making and Trade-Off 12
  4.3 Proposed Design 13
  4.3.1 Overview 13
  4.3.2 Detailed Design and Visual(s) 14
  4.3.3 Functionality 18
  4.3.4 Areas of Concern and Development 18
  4.4 Technology Considerations 19
  4.5 Design Analysis 19
5 Testing 19
  5.1 Unit Testing 19

5.2 Interface Testing 20
5.3 Integration Testing 20
5.4 System Testing 20
5.5 Regression Testing 20
5.6 Acceptance Testing 20
5.7 Results 20
6 Implementation 21
7 Professional Responsibility 21
7.1 Areas of Responsibility 21
7.2 Project Specific Professional Responsibility Areas 22
7.3 Most Applicable Professional Responsibility Area 22
8 Closing Material 22
8.1 Discussion 22
8.2 Conclusion 23
9 Team 23
9.1 Team Members 23
9.2 Required Skill Sets for Your Project 23
9.3 Skill Sets covered by the Team 23
9.4 Project Management Style Adopted by the team 23
9.5 Initial Project Management Roles 24
9.6 Team Contract 24

Table of Figures

Figure 1: Task decomposition 7
Figure 2: Initial Block Diagram 13
Figure 3: Hardware Block Diagram 14
Figure 4: Software Block Diagram 15
Figure 5: MAX Chip 2 wire Connection 16
Figure 6: MAX Chip 2 Equivalent Circuit 17

1. Introduction

1.1 Problem Statement

Sukup is developing a device to measure the temperature inside grain dryers using resistive temperature devices (RTDs); they need a way to test the functionality of their device. The testing device for their temperature device must be able to test the accuracy of the chip used to calculate the temperature from the RTDs, test fault conditions of the device, such as over/under voltage and open/short circuit conditions, as well as confirm the board communicates with the outside world correctly through Modbus communication.

This test device will help ensure that no temperature measuring device that isn’t working properly makes it into the field where it could allow a grain dryer to get too hot, potentially to the point of combustion, before alerting someone of the temperature. The test device can also be used to help improve the temperature device throughout its development.

The main issue is with the test device's own accuracy. If this is not properly accounted for, temperature devices that are not suitable to be installed into a dryer could pass all the tests from the testing device, resulting in a faulty temperature device in the field. The accuracy of the test device will be accounted for by considering the tolerance the components used to make it. The test device will show a failed test in the event that its own error carries outside the acceptable bounds for a given test.

1.2 Intended Users

- Sukup Electrical Engineer
    - The Sukup Electrical Engineer is responsible for designing, programming, and creation of PCB for RTD testing. The skills the electrical engineer has are well rounded in circuit design, PCB best practices, and power electronics. The user needs to have a way to test their RTD designs quickly and effectively. The electrical engineer will benefit from the design by being able to increase production rates and verify designs quickly.

- Technician
    - The Technician is involved with assembly and quality assurance processes of Sukup's RTD circuit boards. They deal with building and testing circuitry post-construction, the technician plays a role in ensuring that the boards are tested thoroughly and pass inspection before being implemented in the field.

2. Requirements & Constraints

2.1 Requirements

Functional:

- Measurement Accuracy: Verify the accuracy of the measurement chip (MAX31865).
- RTD Simulation: Simulate RTD resistance to test different scenarios.
- Fault Condition Testing: Test various fault conditions such as shorts and opens.
- RS485 Compatibility: Ensure compatibility with RS485 communication.
- Modbus Communication Testing: Ensure testing of Modbus communication protocols.
- Data Transmission: Send test results to a computer for analysis.
- Test Flexibility: Allow the device to run specific tests individually or execute a comprehensive sweep of all tests.

Physical:

- Power Supply: The device should be compatible with standard wall outlets.
- USB Connectivity: Include a standard USB-A connector for data transfer and programming.
- Form Factor: Design should have the device be desktop-sized.

UI:

- LCD Display: Equip the device with an LCD display to give device results and data.
- Computer Interface: Display current test run and results associated with tests performed

2.2 Engineering Standards

- Standard Reference Designations for Electrical and Electronics Parts and Equipments (IEEE Std 200-1978)
  - Standard used for best practices in designating parts used for our design.
- Standard For Test Code for Resistance Measurement (IEEE Std 118-1978)
  - Standard used as a reference in our coding of resistance measurements

3. Project Plan

3.1 Project Management

The project management style we have chosen is agile. A major reason for this is because as we have learned more about our client's wants and needs from the project, our requirements and design choices have changed. An agile management style also allows us to focus on short term sprint goals that will allow us to better stay on track for finishing the project on time. A downside to this is that we don't have many hard deadlines which could allow us to become distracted and put too much focus on an area that doesn't require it.

3.2 Task Decomposition

We have broken our project into four main tasks that we need to complete. Those tasks are: Pull power from a standard wall outlet, test board accuracy by simulating an RTD using a voltage, test the fault conditions of the board such as open and short circuit conditions, and finally output the results on a GUI. An image of our task decomposition is shown below in figure 1.

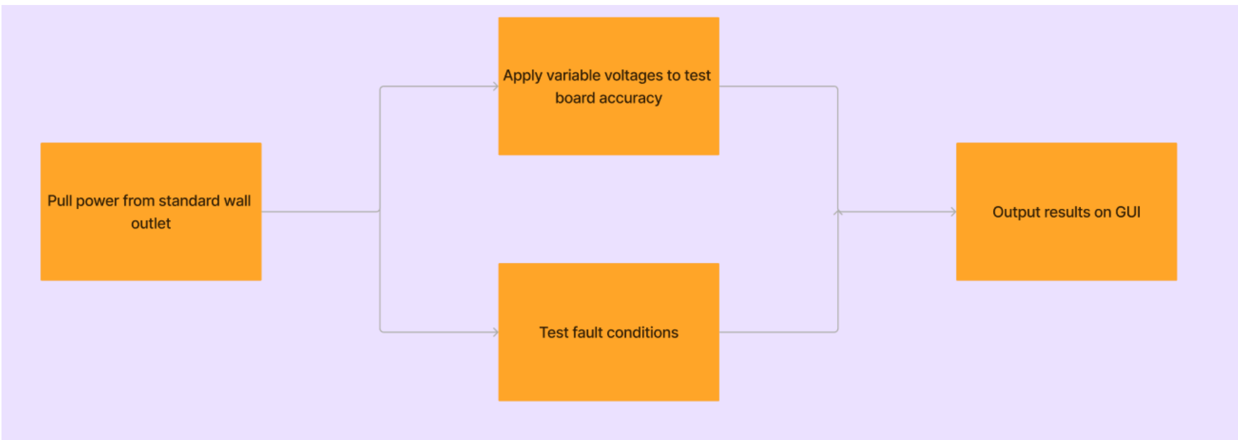

Figure 1: Task decomposition

3.3 Project Milestones

- Design a power supply for our test device
  - Our device must be able to use a standard wall outlet as a power source
- Effectively communicate with Sukup device
  - Our microprocessor will need to communicate with the Sukup board using the Modbus 485 protocol
- Produce accurate voltage to simulate RTD resistance
  - Using a DAC produce accurate voltages to meet resolution requirements defined by the client
- Simulate/detect fault conditions
  - Force fault conditions to be met on Sukup's device to ensure the correct error is read by Sukup microprocessor.
- Display results
  - Display results of all tests on LCD screen GUI
  - Send results to connected computer

3.4 Project Timeline

Our project timeline is currently a bit flexible as discussed with our advisor. We however did want to break the project down into phases where we can look at our project's progression.

We can break it down into three distinct phases which all can have subcomponents. We begin with researching and understanding the board that was given to us by Sukup. This phase will take the majority of our first semester as it is critical in constructing a PCB that meets all the requirements set for us. We start by looking at the schematics and code shared so we can fully understand the data we are testing.

From there we move onto designing our own PCB that we hope to have done by the end of the semester. This phase includes schematic creation, peer reviews, revisions, and PCB layout. For each of these steps our team will meet with our advisor to make sure that our board is constructed properly and ready for fabrication. Once the board is fabricated we can focus the majority of next semester on testing and revisions. This will help give us plenty of time to test our board against the Sukup board as well as make any revisions to the schematics based on our clients response.

RTD Research - February 20th
Maxchip Research - February 20th
Solution Brainstorming - February 27th
Sukup Board Communication - March 26th
RTD Tests and Measurements - April 9th
DAC selections and lookup tables - April 16th
Microcontroller part selection - April 20th
Component final selection and PCB design setup - May 5th

3.5 Risks/Mitigation

There can be a few risks seen when creating a PCB such as delays in fabrication. Each fabricator has a different fabrication time that we will be waiting on during our semester. We hope to help mitigate this by using this time to code on a microcontroller that will be the same as the one on our PCB. We will also mitigate this by having our design finished by the semester so that fabrication can take place over the summer if necessary. Overall the biggest risk to our project is time as there will be periods where we will not have control over how fast our board is being produced.

3.6 Personnel Effort Requirements

This project will require a significant amount of effort from all members of the group. When creating any PCB design it requires various people taking a look and making comments on schematic choices. By having peer reviews we can answer questions and have a collaborative effort on our design choices. There is plenty of new learning and skills to be developed as all members of our group are EE majors with not much coding experience. There is a significant portion of the project that will require us to learn and develop in python.

3.7 Other Resource Requirements

Other resources we will need to complete this project are:

- Power converter (120 VAC to 24 VDC)
- Voltage regulator (24 VDC to 5 VDC, 5 VDC to 3.3 VDC)
- Microcontroller
- LCD display
- Digital to analog converter
- RS485 to USB converter

4. Design

4.1 Design Context

4.1.1 Broader Context

Looking at the broader context of our design we can see the environmental and economic impact of our design choices. It can be a bit difficult to see the broader context for our design as it is a one off board created to test a variety of other boards. With this design however, it would allow for Sukup to test their boards and make sure they are sending out fully functional devices. These devices could impact grain ignition that could cause safety hazards due to the fire produced. We also will see a financial impact as there would no longer be a need for technicians to test these devices so often. The test cases created would solve these issues and return information specific to that board reducing man hours needed.

4.1.2 Prior Work/Solutions

Looking at the prior work done on our project we noticed that the design that was created for most of the schematics had not been analyzed or questioned in quite some time. The schematic was created by a contractor that did not document the design choices and was handed off multiple times. There were a few questions from our contact at Sukup that we decided to take on. There were components that were unsure of the impact on measurements that were tested and verified.

Looking at the other competitors on the market we were able to identify three major competitors in the market. These competitors all offer methods in testing equipment that our

	Modbus	Applicos	Labjack	Our Board
Pros	Developers of the software that we are testing Allows users to define their own series of tests	Has tests and test equipment developed Software is well developed and has resources	Free GUI Devices that already test wanted information	Specially designed for a specific application Can offer the flexibility needed by our client
Cons	Only a software simulation Not available in hardware to test individual boards	Mostly focuses on mixed signal applications Less flexibility in tests that can be ran Software code base not available for editing Does not test Modbus communication protocol	No support for desired communication type	Won't have the GUI sophistication that our competitors have Test cases will be a bit simpler than those on offer from others

contact at Sukup could use. After listing out the benefits and drawbacks, we believe that we offer a level of flexibility that they do not.

4.1.3 Technical Complexity

The complexity of the design showcases the expertise that was developed across Iowa State's Curriculum. Design requires knowledge of power supplies, usage of microcontrollers, and the functionality of different voltage monitors. We are also using code to help run test cases as well as return information about our system. Device interconnections have to communicate with each other using different communication protocols. Knowledge of PCB design and common practices used to produce a functioning board

4.2.1 Design Decisions

There have been various design choices that had to be made in order to successfully accomplish our target goal. Our first decision was the method we wanted to communicate with the board. We explored a few ideas in communicating such as looking at devices similar to our competitors. We however came to the conclusion of commuting through a daughter board that could be plugged into multiple boards under tests. This custom PCB would allow us to have more flexibility and control over the test we are able to run.

The next decision to be made was the approach we wanted to take in order to simulate the RTDs resistance. The RTDs resistance needed to be simulated for a testing range in order to verify that the board under test was behaving correctly. The decision was to try and simulate a voltage as the MAX chip takes a voltage reference that is used to perform its measurements.

The third choice we will have to make is the DACs we will want to use for simulating a voltage to the MAX chip. There is a wide range of DACs available ranging from different bit resolutions that will be crucial in accurately simulating a given voltage. We will most likely select a DAC that is 8 or 10 bits as this allows our step size to be small enough to differentiate between multiple temperatures.

4.2.2 Ideation

The design decision that we spent the most time on was the method in which we wanted to simulate the RTDs resistance. We went through an option of simulating a voltage directly with a power supply, analog potentiometers, digital potentiometer in parallel, 8 bit DAC, and a 10 bit DAC. Each of these choices had discussions over what would be the best method for testing. These options all provide a way to simulate the voltage seen in place of the RTD but have different temperature resolutions. After speaking with our advisor we decided to use a 10 bit DAC that allows for high resolution and small temperature step sizes.

4.2.3 Decision-Making and Trade-Off

Each of the options had pros and cons to them. Starting with simulating the voltage directly we would be able to easily simulate the voltage we liked. This would be the easiest and quickest way to accomplish our goal. However the con is that it would be the slowest way as you would need to connect all power supply cables for each test and physically change the power supply.

The next design choice we considered was using analog potentiometers. This would all allow us to change the resistance on the board to the values we want. It allows for a small resolution size as we can tune the resistance. The issue with this approach is that it is also quite slow. You would need to adjust the potentiometer each time you wanted to take a new measurement as well as take measurements of the potentiometers resistance.

The next option was using a digital potentiometer in parallel. This method would allow us to quickly change the resistance of the potentiometer using code rather than physically tuning the potentiometer. The issue with this design is that the most TAPs we could find was 256 which is not enough resolution to support our test range. The change in resistances between TAPs was just too large to get an accurate sweep of voltages.

Our final choice was either using an 8 bit DAC or 10 bit DAC. These two offer the benefit of simulating a voltage using code so we can quickly change the voltage that is being output. The DAC allows for quick testing and accurate measurements. The issues we had to consider for the two is that we needed to check if the step sizes would be small enough for our desired resolution. The tradeoff between an 8 bit and 10 bit DAC would be the price and resolution. A 8 bit DAC would be cheaper but have a larger resolution while a 10 bit DAC would have a smaller resolution but be more expensive.

4.3 Proposed Design

4.3.1 Overview

Our board will be used to communicate tests and data transmission to and from the Sukup board. Tests will be defined by the user through software and then run from our circuit board to read behavior and conditions from the Sukup board. To drive voltages into the Sukup board a DAC will be used to get accurate desired voltages to simulate the small differences seen by the Sukup board when taking measurements. We plan to include the following sub systems:

- Personal Computer
  - Used to interface software and hardware components
- Data Converter
  - Used to translate from usb to rs485 signals
- Power and Cable
  - Input of wall power stepped down to usable levels
- Transceiver
  - Used to communicate between the microcontroller and software
- MCU
  - Used to run desired test software and record/report results
- On Board Power Regulation
  - Used to further step down voltages to different desired levels
- DAC
  - Used to drive simulated readings into Sukups host board

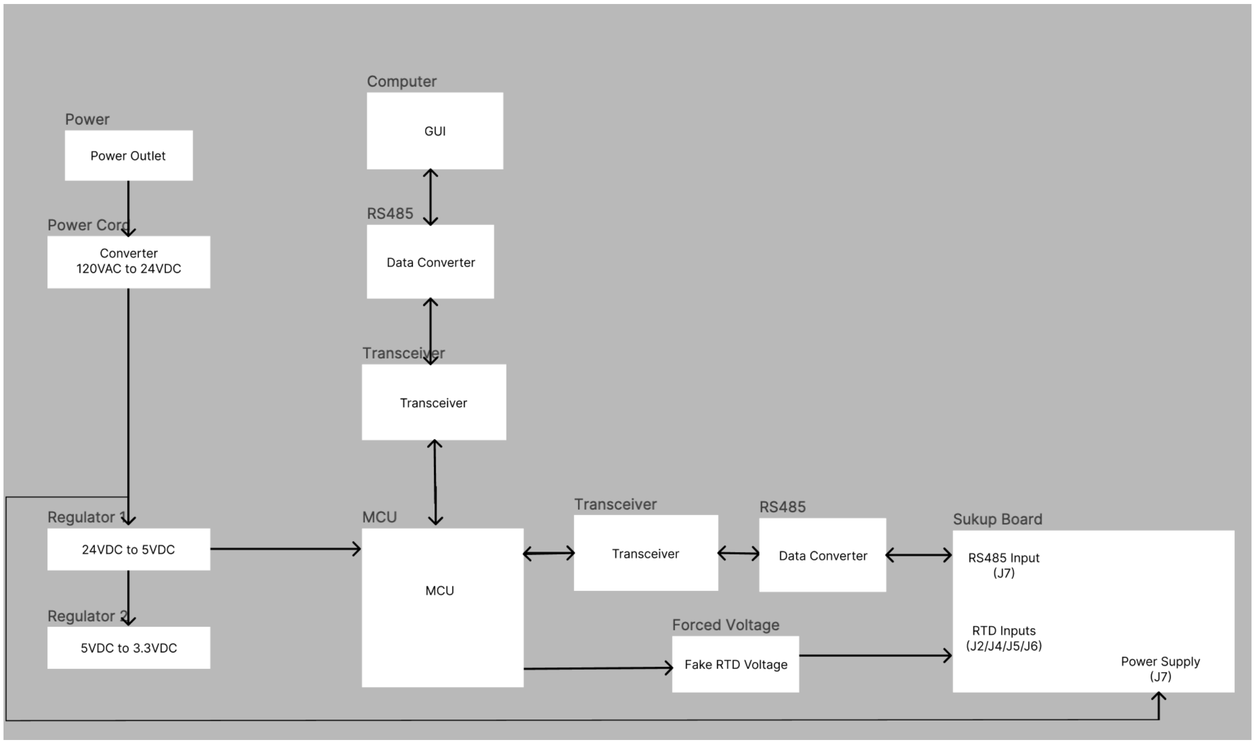

Figure 2: Initial Block Diagram

4.3.2 Detailed Design and Visuals

Seen in the following refined block diagram are the subcomponents with more specified values. We decided to split up into two separate block diagrams as we will be working with both hardware and software. In the hardware diagram we see all of the physical components that will need to be selected in order to make a functional circuit along with descriptions of their roles.

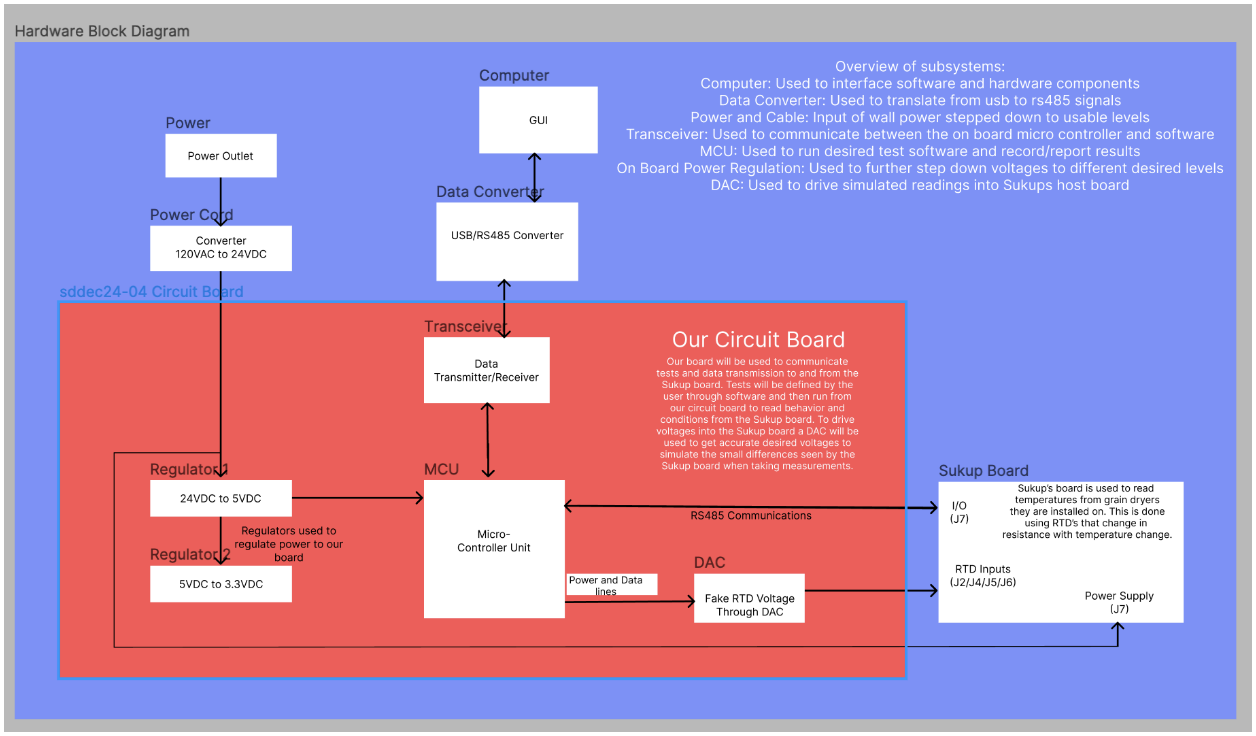

Figure 3: Hardware Block Diagram

The software block diagram shows our anticipated software flow for running tests. The tests we plan to run are giving the user the option to run individual tests as well as a sweep of all tests. One of the requirements we were given was to allow for user flexibility, we want to include the option to alter tests through the GUI without changing the core functionality such as changing the RTD value between 100 and 1000.

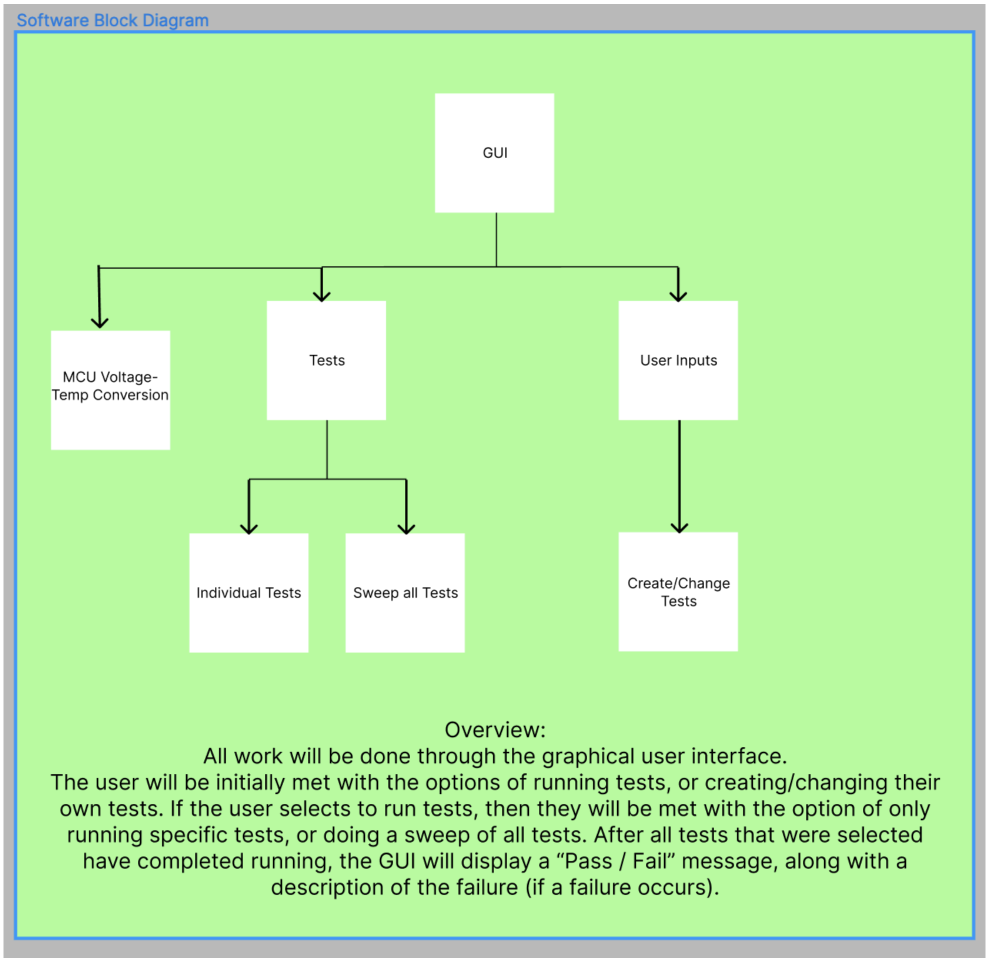

Figure 4: Software Block Diagram

When looking at our block diagram we are able to get more in detail for a few specific subcomponents. Some of the most important components are going to be the ones relating to “faking” the RTD voltage. These components are the DAC, MAX chip, and the microcontroller. Starting with the MAX chip we needed a thorough understanding of the way that measurements are taken and interpreted by Sukups board. In the figure below we can see the typical setup given in the datasheet for the chip.

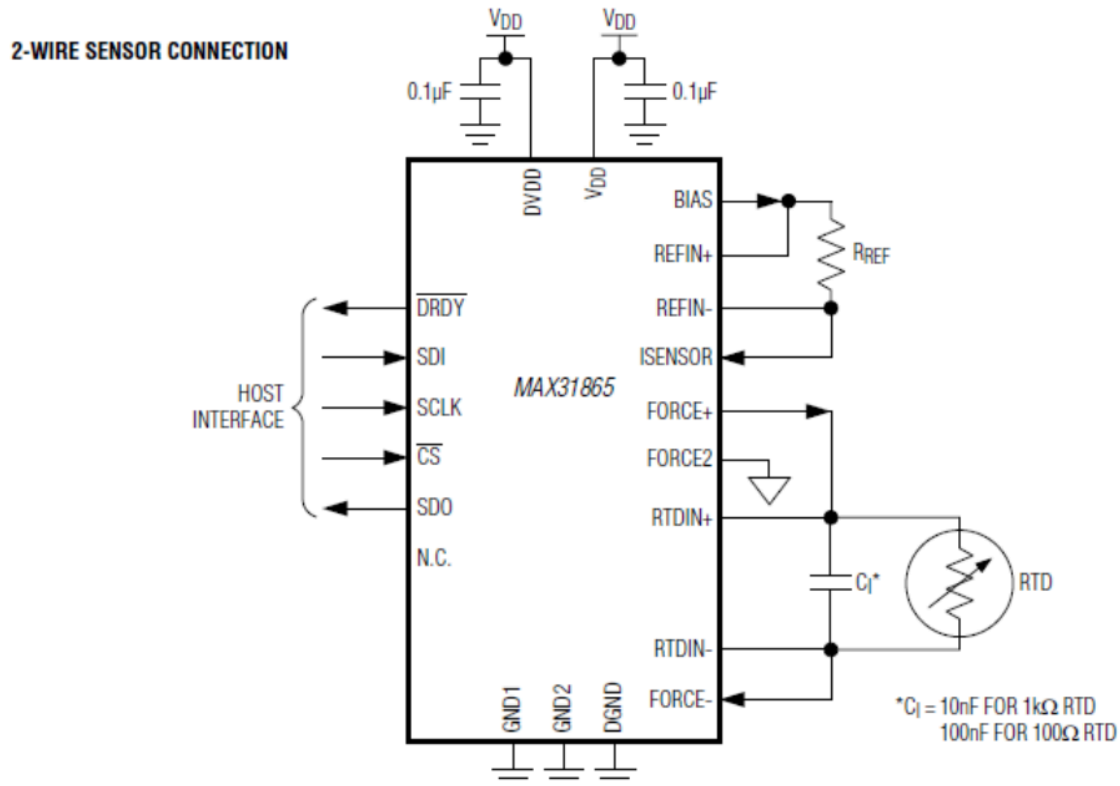

Figure 5: MAX Chip 2 wire Connection

When looking at the MAX chip we can see that we take the ratio between Vref and Vin produced by the changing resistance of the RTD. The Vref voltage is then taken into the ADC and the MAX chip does internal processing to return a corresponding 15 bit output. This output is then correlated to the temperature seen in the environment.

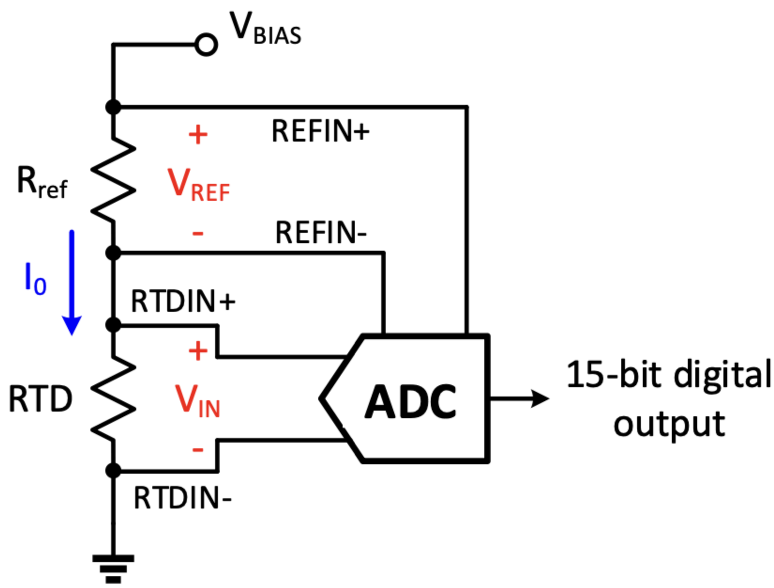

Figure 6: MAX Chip 2 Equivalent Circuit

Moving forward to the DAC, we needed to select a DAC that could support the resolution requirements defined by our Sukup contact. By using the fact that the step size of a DAC is the max output divided by the number of steps we can see that the resolution achieved through using a 3 V, 12-bit DAC is 0.73 mV per step. This allows us to change small voltages and correspond those voltages to a temperature range.

4.3.3 Functionality

Our device is intended to help improve the design of the temperature sensor that Sukup is currently producing. The user will use our device to check different criteria of the Sukup device to both find possible flaws in the design as well as test each individual device for issues. Our device will be stationary and indoors, so it does not require any protection against outside elements other than the possibility of being dropped.

The user should have the ability and flexibility to respond to these issues by running a test case for the device that they are testing. We want the device we are creating to be able to run on multiple RTDs if the user decides to change their design.

4.3.4 Areas of Concern and Development

Our current design meets the needs and requirements of our client well. The biggest issue we are currently facing is the heat that might be put off in our power supply. This could be an issue for a few reasons, the biggest being it could affect the performance of the components that are near it. It could cause the nearby components to behave in a way we don't plan on them behaving, or cause them to stop working all together. We are currently working on designing a better power supply so not as much heat will be produced, hopefully improving the longevity of our device.

4.4 Technology Considerations

- Voltage converter
  - Simple and easy way to bring 120 VAC to 24 VDC
  - Can be somewhat bulky
- Voltage Regulators
  - Can produce a lot of heat
  - limits the voltage supplied to components in our device
- Digital to analog converter
  - Easy way to produce accurate voltage
  - Need higher bit converter to improve result resolution
- RS485
  - Already used for existing Sukup device
- LCD Display
  - Easy to use and read
  - Could be difficult to display some of the desired information

4.5 Design Analysis

We have so far accomplished a rough design for our PCB. We know the components that are needed and the specs that are going to be required. We have also established communication between the board that Sukup has given us. This board has test code that allows us to read registers that correlate to temperature. Our design from 4.3 has had tables created that can help relate an equation to temperature using the voltages the DAC can produce.

The plan for the future board is to create a PCB with a BOM by the end of the semester. This PCB should have the components layed out and routed so that it can be manufactured by the end of the summer. That way we are able to test the functionality of the board and make edits to the schematic if necessary.

5. Testing

5.1 Unit Testing

The units we will be testing on our design are the accuracy and output of our DAC. Our DAC needs to be able to produce a specific voltage that corresponds to the RTDs resistance. This will be crucial in providing an accurate simulation of the RTD for testing. We will also be testing the Modbus communication protocol that allows us to verify that the board communicates effectively. These parts will be tested to the extremes as we are most concerned with the points that would cause alerts for grain ignition.

5.2 Interface Testing

The interface that we will be testing is the Modbus communication interface as well as the code output into our terminal. We went through our design and felt that the test cases would most well be written in python and ran through the command terminal. This would help ensure that all of our test cases are being run properly and are accessible even remotely for edits. This would also allow for the flexibility to change tests quickly without handling a GUI.

5.3 Integration Testing

The most important part of integration must be with the board that Sukup provides. Without the two boards working together the project will not work. We will test the integration with the other board at various points in the design processes. We have been testing the communication between the board provided with us and the current RTD setup. Those tests have been working well and have gotten effective data back.

5.4 System Testing

The system is going to be tested as a combination of all components that were listed in the document. It will require that our components work together to produce accurate results and readings. The system we believe will show if our design works with Sukups design as well as when we alter portions of the test cases.

5.5 Regression Testing

In regression testing we see if new additions will break the previous build. We do not anticipate this to be a major issue in our design as it is mostly hardware. Once a PCB is constructed there is not much we can do to add to that design. This would require us to rethink our schematic and approach to the problem and make edits to this on a new PCB. As for software, it would be quite simple to add test cases to our microcontroller as well as to Sukups board. This should not break the functionality of our board.

5.6 Acceptance Testing

For acceptance testing we plan to include our client in this process. We want to give them the chance to give feedback on the test cases we have created. We will assess the goals and requirements document to see if we have accomplished this. Going through this with our client will help verify that we are meeting their expectations and needs.

5.7 Results

Results will be recorded and documented. There are no current results to report as it requires the construction of a PCB

6. Implementation

Some plans for implementation we have had is to connect our PCB to the test board and ensure that we are able to send simple test cases for communication. This will help us see that our design does the basic parts well. We will then run a sweep across different voltages that simulate the RTDs values and compare to our predicted values. Implementing with Sukups current design will be discussed more at our next meeting to see what field testing will look like.

7. Professional Responsibility

7.1 Areas of Responsibility

Area of Responsibility	Definition	NSPE Canon	IEE Code of Ethics 9 (Avoid injury by false action)
Work Competence	Perform work of high quality, integrity, timeliness, and professional competence	Perform services only in areas of their competence; Avoid deceptive acts	Avoid intentionally making decisions that could cause harm
Financial Responsibility	Deliver products and services of realizable value and at reasonable costs	Act for each employer or client as faithful agents or trustees	Act in a way as to not deceive clients
Communication Honesty	Report work truthfully, without deception, and understandable to stakeholders	Issue public statements only in an objective and truthful manner; Avoid deceptive acts	Report issues truthfully and without deceit
Health, Safety,Well-Being	Minimize risks to safety, health, and well being of stakeholders	Hold paramount the safety, health, and welfare of the public	Avoid injury to others by false or malicious actions
Property Ownership	Respect property, ideas, and information of clients and others	Act for each employer or client as faithful agents or trustees	Act in a way as to not intentionally harm another's property
Sustainability	Protect environment and natural resources locally and globally		Protect the environment as to not cause injury to others
Social Responsibility	Produce products and services that benefit society and communities	Conduct themselves honorable, respectively, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the	Report issues that may cause harm to society

		profession	

7.2 Project Specific Professional Responsibility Areas

Because our project is so specific to a single need, not many of the professional responsibility areas apply directly.

- Work Competence
  - Our team must work to design and produce a quality product that will solve the issue we have been presented
- Financial Responsibility
  - Our project is relatively small and will have no issues staying under the budget provided
- Communication Honesty
  - Our team is constantly staying in touch with our client as well as each other and our advisor
- Health, Safety, Well-being
  - Our product will help minimize the risk of grain becoming too hot and combusting
- Property Ownership
  - Our team is designing our product from scratch and not plagiarizing similar ideas that may be available
- Sustainability
  - Our product will help reduce fires and save grain production
- Social Responsibility
  - Our product will help prevent grain from going to waste

7.3 Most Applicable Professional Responsibility Area

The most applicable responsibility area to our project is work competence or communication honesty. We must work hard to produce a quality product that effectively accomplishes the required tasks. To do this we must also communicate often and effectively with not only ourselves but with others that are not as involved with the design and production processes.

8. Closing Material

8.2 Conclusion

We are working with Sukup to create an automated test board to test an RTD circuit that Sukup is creating. Our goal is to reduce the amount of manual testing to reduce the amount of time for prototyping, development and final assembly checks. To achieve this it will have pre-set tests that are easy and quick to run, and custom tests which allow our client to create and define their own test cases. The pre-defined tests will be open and short circuit conditions of the RTDs, correct Modbus communications, and ability to appropriately handle power surges.

9. Team

9.1 Team Members

- Samuel Estrada
- Justin Garden
- Tony Haberkorn
- Michael Hurley

9.2 Required Skill Set

The design requires knowledge of power supplies, usage of microcontrollers, and the functionality of different voltage monitors. We are also using code to help run test cases as well as return information about our system. In addition, device interconnections have to communicate with each other using different communication protocols. We will also need the knowledge of PCB design and common practices used to produce a functioning board

9.3 Skill Sets Covered by Team

- Samuel Estrada - skill sets provided by this team member is experience coding test cases in python, hardware development, PCB design, and analog part testing.
- Justin Garden - Skill set includes PCB design, circuit design, and microcontroller programming
- Tony Haberkorn - Skill sets include circuit design, RTD knowledge and block schematic diagrams
- Michael Hurley - Skills include PCB design and assembly, Altium experience and circuit testing and troubleshooting.

9.4 Project Management Style

The project management style we have chosen is agile. A major reason for this is because as we have learned more about our client’s wants and needs from the project, our requirements and design choices have changed. An agile management style also allows us to focus on short term sprint goals that will allow us to better stay on track for finishing the project on time. A downside to this is that we don’t have many hard deadlines which could allow us to become distracted and put too much focus on an area that doesn’t require it.

9.5 Initial Project Management Roles

Justin - Handled client relations and DAC conversion charts

Sam - Handling PCB design review methods and python script coding

Tony - Handled hardware and power management

Michael - Handling the Altium PCB designer workspace

9.6 Team Contract

Team Name ____Sddec24-04________________________

Team Members:

1) _Anthony_Haberkorn______________ 2) _Justin_Garden__________________
3) _Michael_Hurley_________________ 4) _Samuel_Estrada_________________
5) ________________________________ 6) ________________________________
7) ________________________________ 8) ________________________________

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team meetings:
   Face-to-face meetings on Sunday on a weekly basis (4:00pm) located at TLA/Library.

2. Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face):
   -**Phone and face-to-face meetings**
3. Decision-making policy (e.g., consensus, majority vote):
   - **Majority Vote**
4. Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived):
   -Google drive folder

Participation Expectations

1. Expected individual attendance, punctuality, and participation at all team meetings:
   -Be able to attend all meetings unless extenuating circumstances arise on time and make meaningful contributions during meetings.

2. Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:
   -Full responsibility for individual assignments, timelines and deadlines should be reasonable timelines able to be met often.

3. Expected level of communication with other team members:
   -Be able to communicate on task updates and help needed in a timely manner through the specified communication channels.

4. Expected level of commitment to team decisions and tasks:
   -Be able to put forth enough time outside of scheduled meetings to keep up on tasks and push the project forward.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):
   Tony Haberkorn - Organization
   Michael Hurley - Individual component design
   Samuel Estrada - Testing
   Justin Garden - Client interaction
2. Strategies for supporting and guiding the work of all team members:
   -Individual updates at each weekly meeting
   -Work reviews with questions/comments from team members
3. Strategies for recognizing the contributions of all team members:
   -Individual updates at each weekly meeting

Collaboration and Inclusion

1. Describe the skills, expertise, and unique perspectives each team member brings to the team.
   Samuel Estrada - Experience with Altium, kicad, part selection, communication protocols, C, python, and PCB design

   Tony Haberkorn - RTDs, industrial applications, Modelsim, Quartus, CNC cutter

   Michael Hurley- Altium pcb design and manufacturing, digikey part research and choice, matlab/ c coding.

   Justin Garden - Circuit/PCB design, C programming, Component research
2. Strategies for encouraging and supporting contributions and ideas from all team members:
   Give opportunities for team/client feedback during meeting times
3. Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment is obstructing their opportunity or ability to contribute?):
   - Talk during meetings and bring up issues. Can also talk to advisor
   - Communicate issues as they come up in a timely manner

Goal-Setting, Planning, and Execution

1. Team goals for this semester:
   Understand Client needs and device applications
   Get to a good jump off point to begin manufacturing and testing.

2. Strategies for planning and assigning individual and team work:
   Break project into manageable small tasks, tasks too large for one individual will be set aside for meeting/ workdays.

3. Strategies for keeping on task:
   -Individual updates at each weekly meeting
   -Work reviews with questions/comments from team members
   -Goals to accomplish during each meeting

Consequences for Not Adhering to Team Contract

1. How will you handle infractions of any of the obligations of this team contract?
   The offender will be reminded of their responsibilities frequently until the next group meeting.
2. What will your team do if the infractions continue?
   It will be brought up to the instructors to determine the best course of action from that point onward

****

a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*
b) *I understand that I am obligated to abide by these terms and conditions.*
c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*
1) ___Justin Garden___________________________________ DATE ____01/30/24______
2) ___Michael_Hurley__________________________________ DATE ____01/30/24______
3) ___Samuel Estrada__________________________________ DATE ____01/30/24______
4) ___Tony Haberkorn__________________________________ DATE _____01/30/24_____