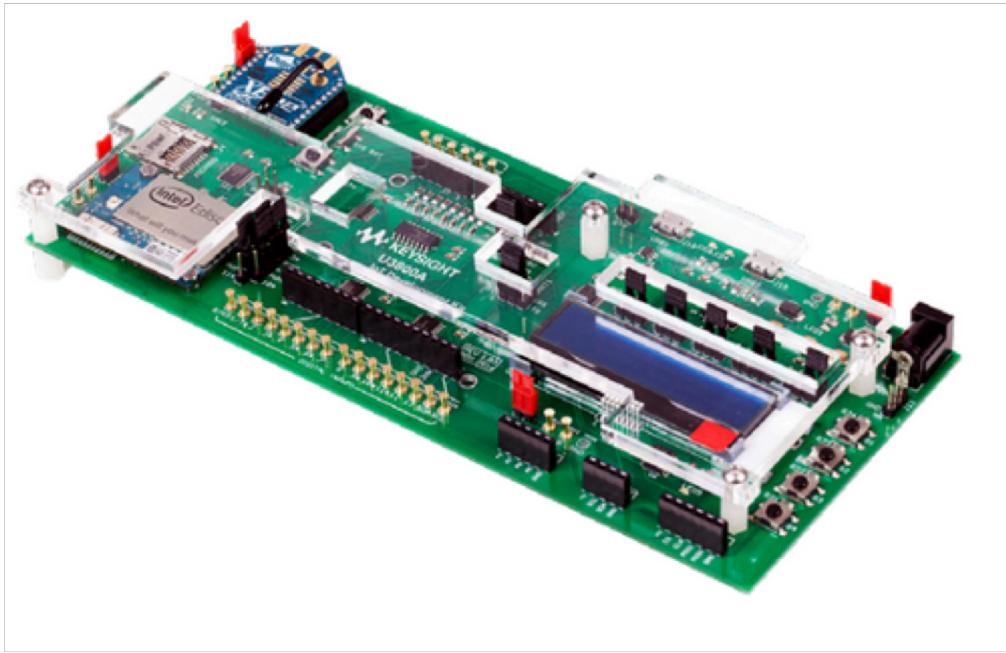


Keysight IoT Courseware



SPONSOR: ARTHUR LIZOTTE, KEYSIGHT TECHNOLOGIES

PROJECT MANAGER: GARRETT WARMKE

JEFF JANG, CODY LUEHLFING

FACULTY ADVISOR: DR. HAROLD STERN



Project Overview

- Smart water management system used to monitor water levels and temperature to keep water pipes from freezing and/or bursting.
- Designed for remote water locations for livestock to reduce labor for ranchers and farmers
- The deliverable includes a system that has the ability to open a valve to drain the water out of the pipe when water temperature reaches 0 degrees Celsius.

Project Motivation

- Reduce travel time to check water levels of stock tanks
- Detect when freezing conditions occur and implement a certain action when it is detected
- Increase safety by removing people from dangerous weather conditions

Cost Comparison

Traveling Cost Per Trip	\$ 75.00
Manpower Cost Per Trip	\$ 50.00
Total Cost Per Trip	\$ 125.00
Average Trips Per Year	5
Average Cost Per Year	\$ 625.00
Cost of Designed System	\$1,100.00
Pay Back Period	2 years

Project Goals

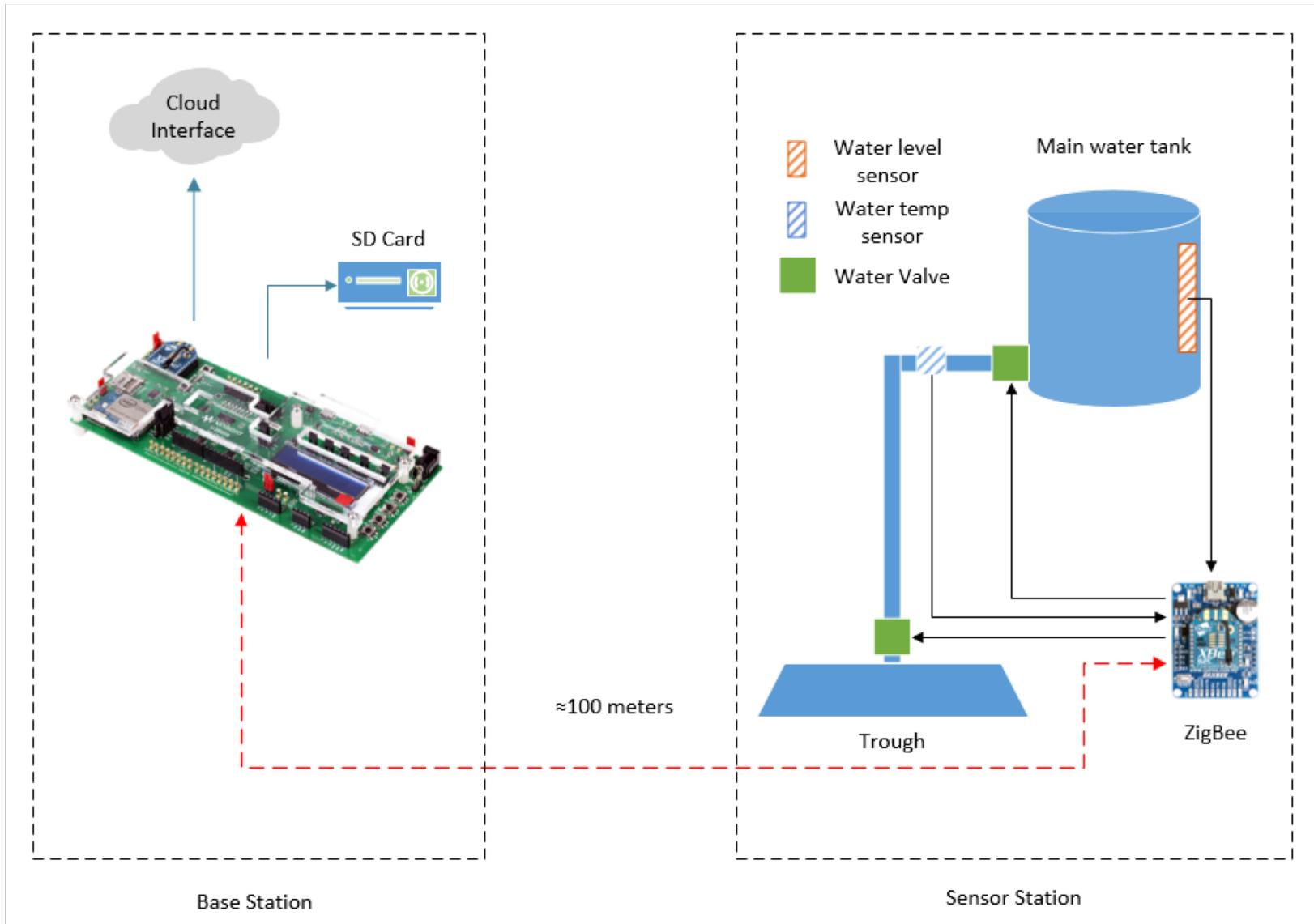
Goals of Project:

- Measure water level and water temperature from a remote location
- Detect Freezing conditions
- Establish communication between the U3800 and the Zigbee
- Write data to an SD-Card
- Print water level on LCD
- Implement automatic updates to the cloud to be checked by user

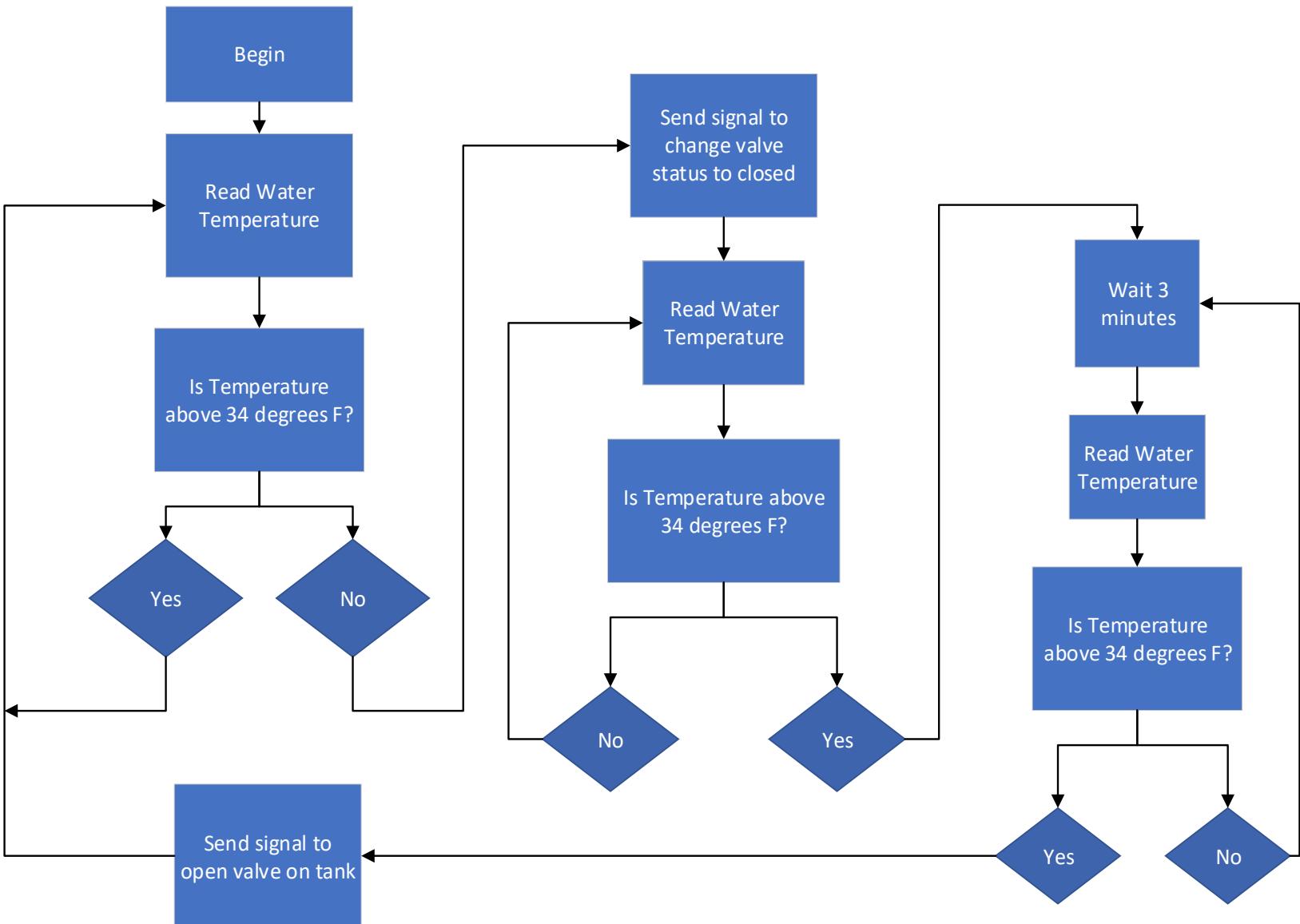
Stretch Goals of Project:

- Implement the opening and closing of valves to drain the pipes when freezing conditions are detected

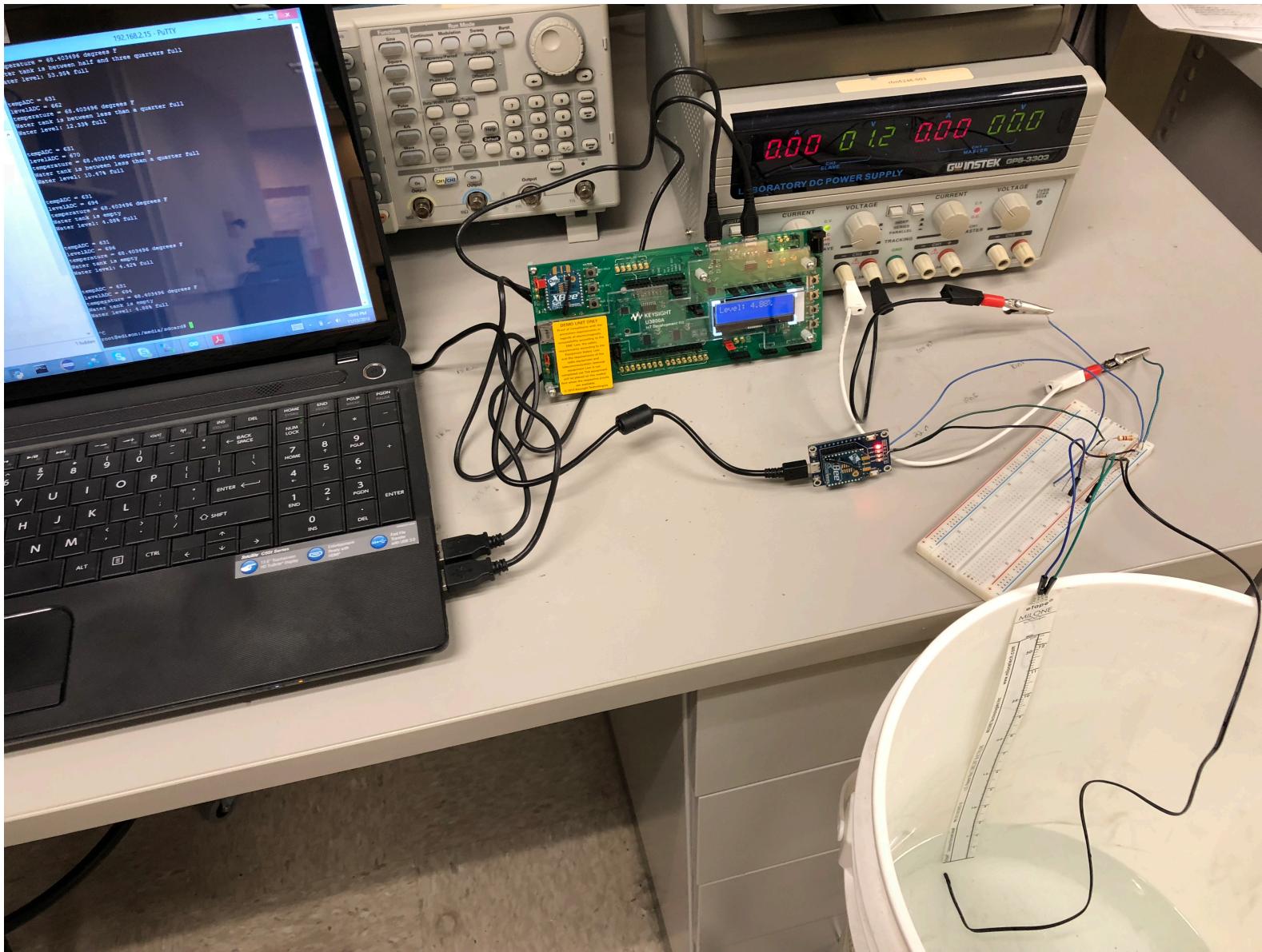
Top Level Diagram



Freeze Detection

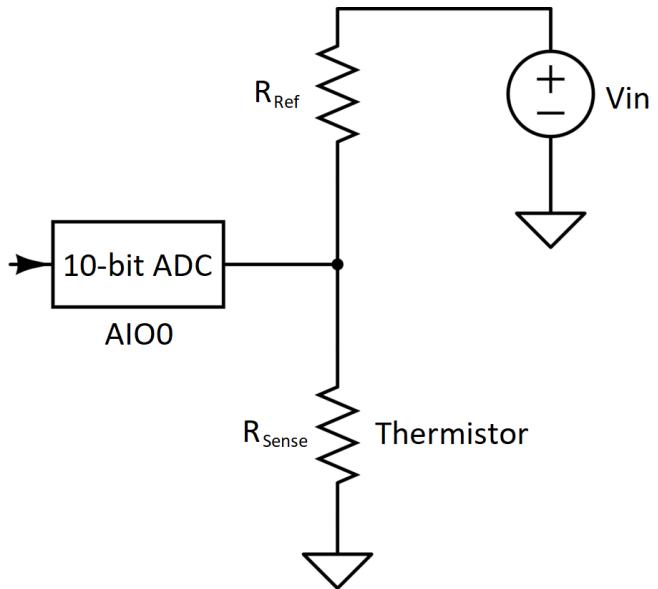


Results



Data

Steinhart-Hart Equation:
Thermistor – Temperature Relationship



$$\text{Temp} = \left(\frac{1}{T_o} + \frac{1}{B} \ln \left(\frac{R}{R_{sense}} \right) \right)^{-1}$$

$$R_{sense} = \frac{R_{ref}}{\frac{ADC_{max}}{ADC} - 1}$$

```
temperature = 93.826134 degrees F
Water tank is empty
Water level: 4.65% full

tempADC = 470
levelADC = 695
temperature = 93.662827 degrees F
Water tank is empty
Water level: 4.65% full

tempADC = 495
levelADC = 695
temperature = 89.624527 degrees F
Water tank is empty
Water level: 4.65% full

tempADC = 563
levelADC = 694
temperature = 78.946144 degrees F
Water tank is empty
Water level: 4.88% full

tempADC = 595
levelADC = 695
temperature = 73.991745 degrees F
Water tank is empty
Water level: 4.65% full

tempADC = 609
levelADC = 695
temperature = 71.823318 degrees F
Water tank is empty
Water level: 4.65% full
```

Results: Test Cases

Test Case	Specifications	Results	Compliance
Freezing Algorithm	The freezing algorithm must send a signal to open the valve when the temperature sensor outputs a temperature of 34 degrees F.	The valve (LED) turned on when the temperature reaches 34 degrees F	Pass
Water Temperature Sensor Data	The water temperature sensor provides accurate readings	Received accurate readings from the water temperature sensor	Pass
Water Level Sensor Data	The water level sensor provides accurate readings	Received accurate readings from the water level sensor	Pass
Data Transfer between U3800 and XBee	Data must be transmitted and received between the U3800 and the XBee	Data was transmitted and received between the U3800 and the XBee	Pass
Communication Distance	The U3800 must be able to receive data from the XBee from a distance of 100m	Data was received from the XBee at a distance of roughly 100m	Pass
Upload data to the cloud	The water level data is automatically uploaded to the cloud as soon as data is read every 1 second	Connected and sent hardcoded data to cloud, but have not been able to integrate it with the actual data	Fail
Implement signal to be sent to shut-off valves	When water temperatures in the holding container drop below 34 degrees F a signal is sent from the U3800 to the XBee to close the valves	Tested with LED that lights up when the water temperature drops below 34 degrees F	Pass

System Deficiencies

- Have not yet been able to upload data to the cloud
- Was able to connect to the cloud utilizing Python
- Have not yet been able to convert it to C to integrate it with the data collection program

Lessons Learned

- Not all hardware have the same software
- Common grounds are important!
- Communication is key

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