# RTCM

Real-Time Coagulopathy Measurement

aptitude

# Development Team

- Trenton Rochelle - Lead, System Architecture, Sensors/Peripherals

- Justin Hemphill - Power Management, Website Management

- Ziming Qi - Software Architecture, Physical Design

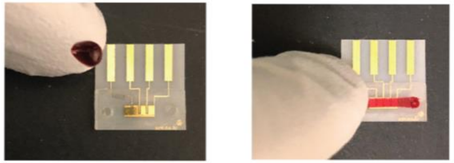
# Problem

- Coagulopathy of trauma is a hypo-coagulable state with increased bleeding, heightened resuscitation requirements, and a 4x increased rate of mortality.
- To minimize mortality, coagulopathy must be assessed and addressed nearest to the time of injury and monitored throughout the course of care.

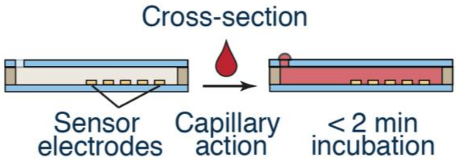
# Solution

- Aptitude is developing RTCM - the first POC fibrinogen sensor.
- It is a handheld sensor analogous to a blood glucose meter
- It can be used in pre-hospital, emergency department, and in perioperative settings to measure fibrinogen in 2 minutes to guide personalized treatment for trauma patients.


# Alpha Prototype



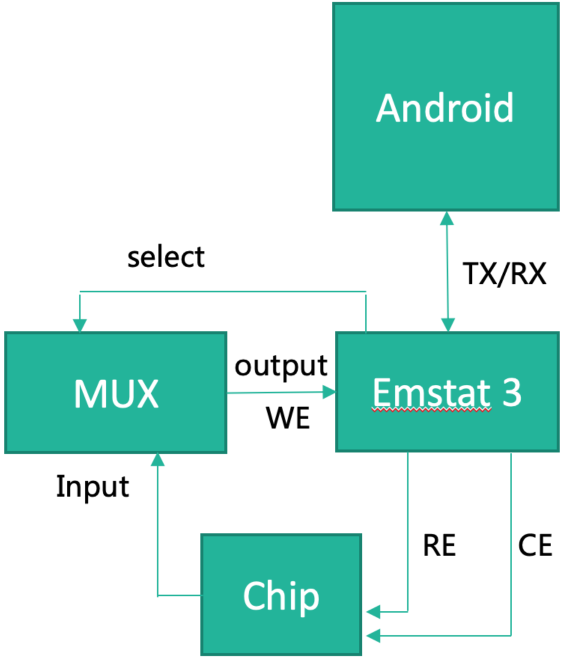
Loading the sample on the sensor



# Prototype System

Limitations:

- No temperature control.
- No new feature expandability.
- No way to charge device without disassembling casing.
- No central controller.



# Our New System

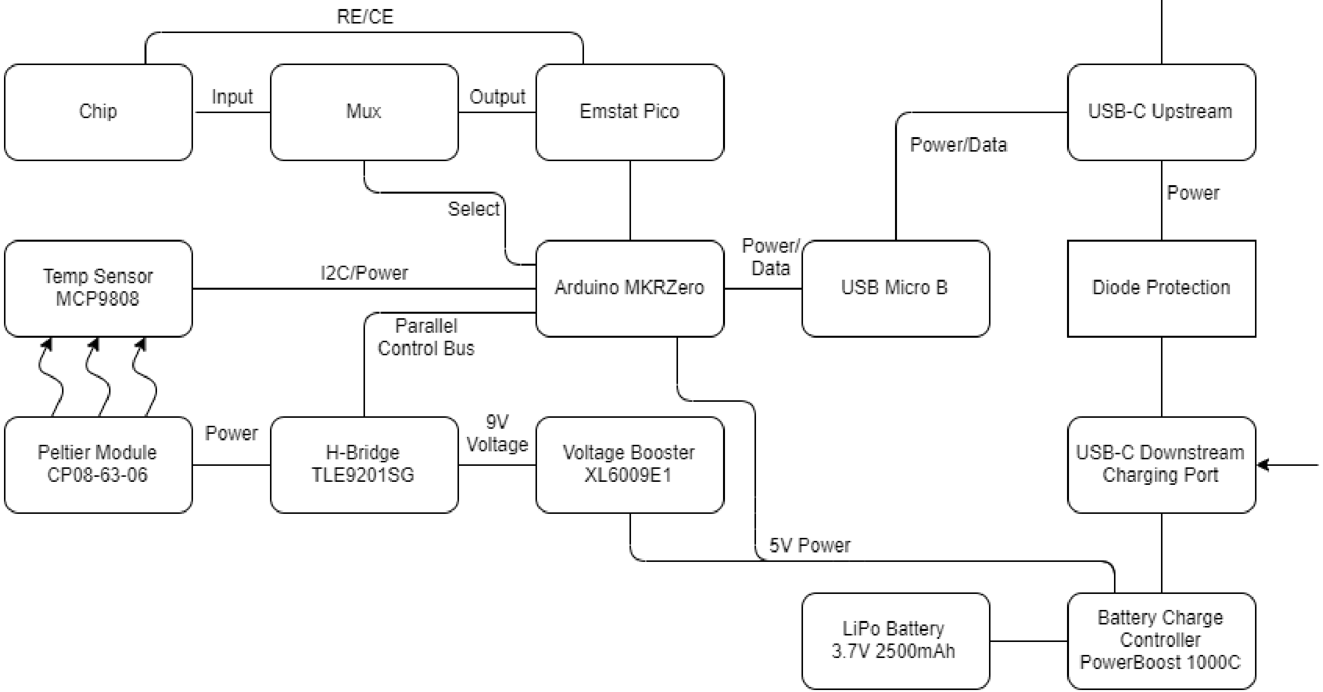
Goals:

- Temperature control
- Device charging
- Redesign enclosure
- Quick, accurate readings
- Extremely High reliability

Design Limitations:

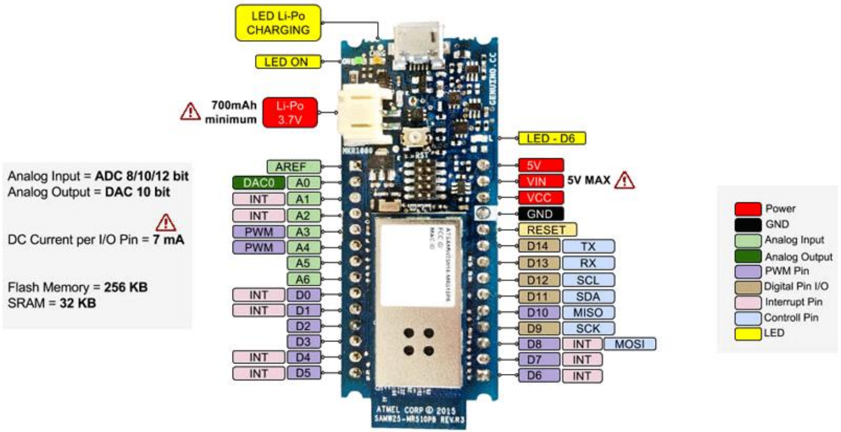
- No bluetooth.
- Must work while charging.
- Must be handheld.
- Long battery life.
- Must work with Android.

# Future System



# Processor

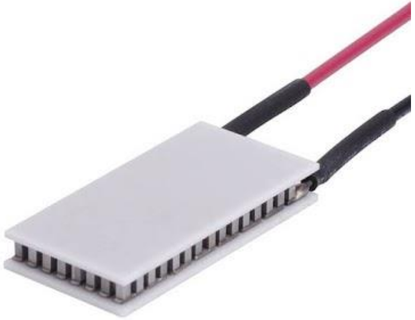
- Microprocessor: Arduino MKRZero
- Processor Name: SAMD21 Cortex-M0+ 32 bit low power ARM MCU
- RAM: 32KB SRAM Memory
- Storage: 256KB in-system self-programmable Flash
- Type: Single-cycle hardware multiplier
- Clock: Internal and external clock options with 48MHz Digital Frequency Locked Loop (DFLL48M) and 48MHz to 96MHz Fractional



# Sensors/Peripherals/Modules

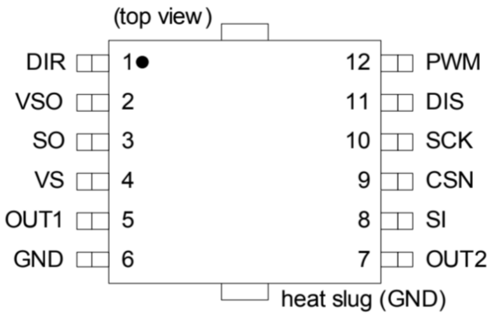
## Peltier Module:

- Dimensions: 24.56mm x 12.29mm x 3.40mm
- Given Voltage: 6.0-9.0V
- Our max current draw: 800mA
- Changes voltage with change in temperature
- Use: Heat/Cool blood chip



## H-Bridge:

- Given Voltage: 6.0-9.0V
- Device max current draw: 6A
- Use: Control Peltier current flow direction and duty cycle



# Sensors/Peripherals/Modules

## Temperature Sensor

- Type: Digital/I2C
- Resolution Used: 0.125 ℃
- Accuracy: 0.25 ℃ (typical), 0.5 ℃ (maximum)
- Polling: 130ms
- Operating Current: 200 µA (typical)
- Voltage Given: 3.3V
- Power Consumed: 660µW
- Use: Get current temperature of the Peltier module

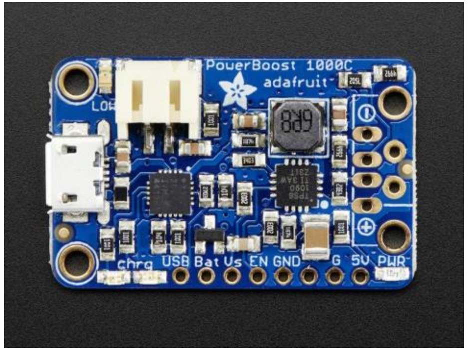
# Power System

## Battery:

- PKCELL Li-Po rechargeable battery
- Voltage: 3.7V
- Energy Capacity: 2500mAh
- Dimension: 47mm x 61mm x 6.7mm
- Use: Supply system power


## Battery Controller:

- PowerBoost 1000C
- Use: Safely charges Li-Po Battery from USB
    - Boosts output to 5V
    - Battery level reading
    - Allows pass through power from charging source



# Power System

## DC-DC Step-Up Boost:

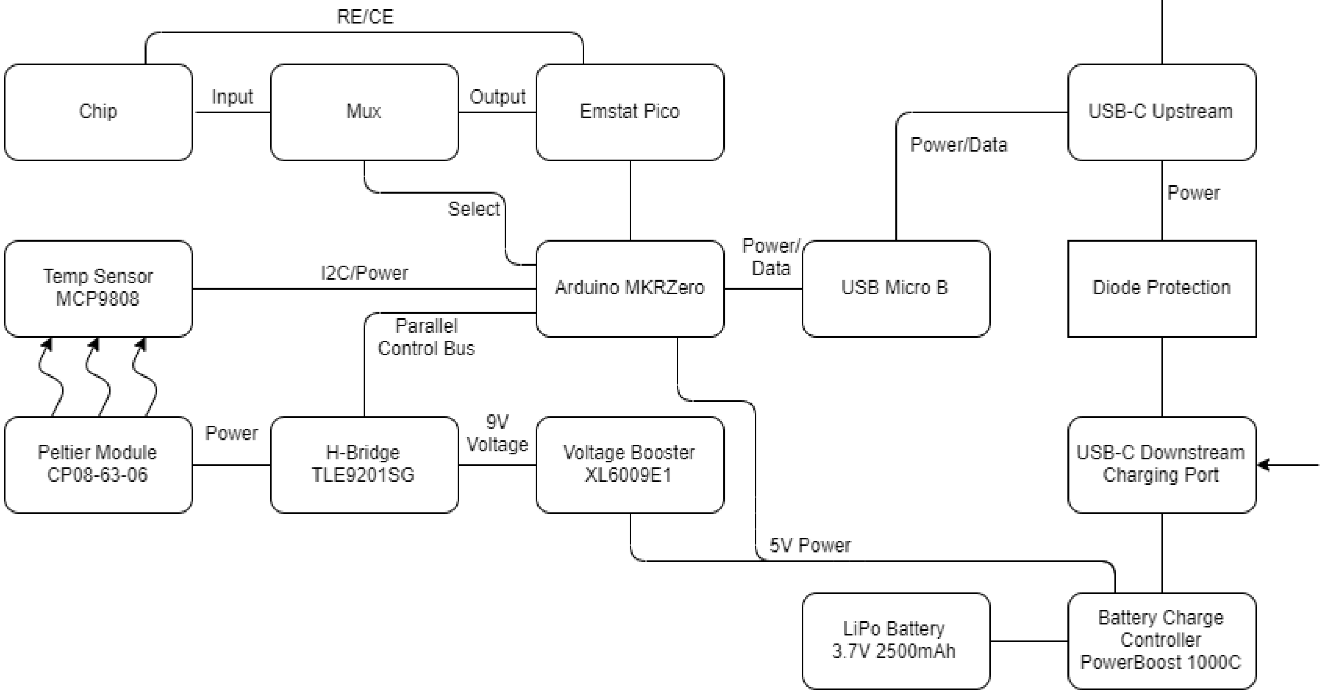
- XL6009
- 5V->7V
- Use: Supply H-Bridge with enough voltage to meet Peltier current/voltage demands

## USB Breakouts:

- USB-C Downstream/Upstream
- USB Micro-B
- Use: power/communication



# Future System



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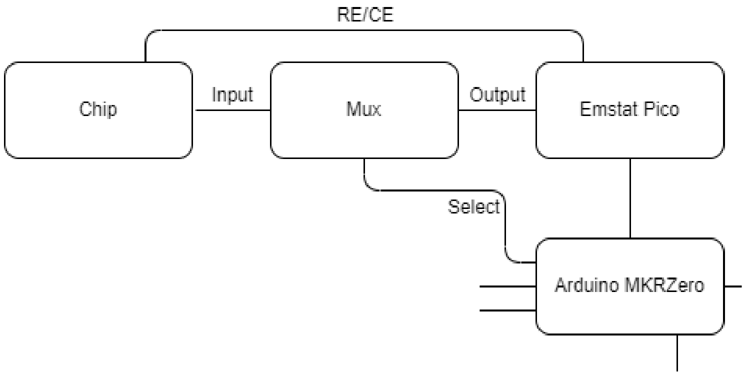

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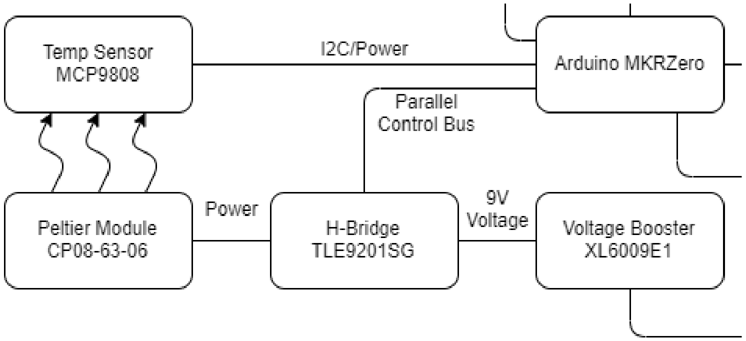

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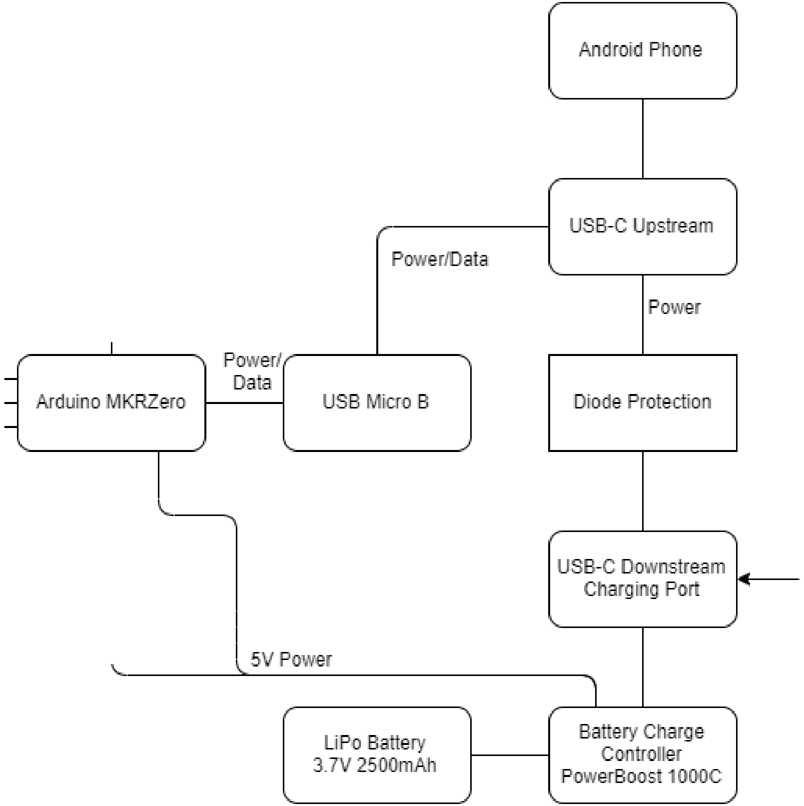

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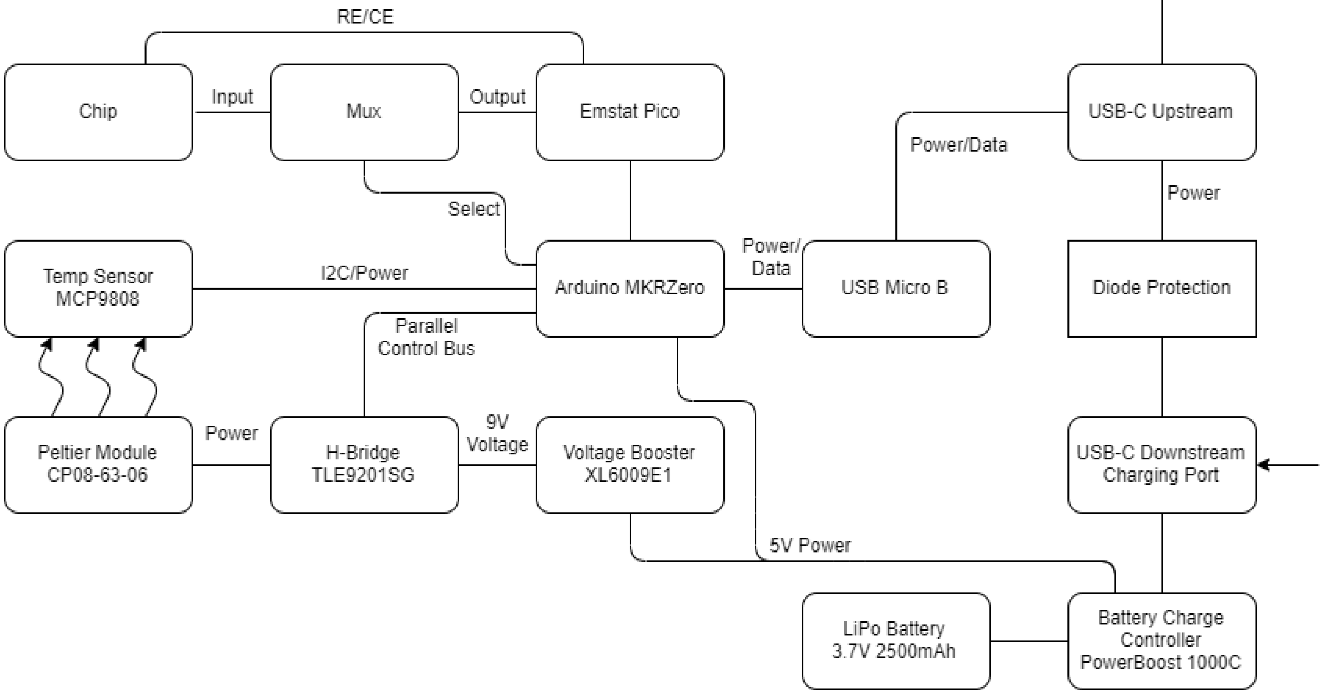
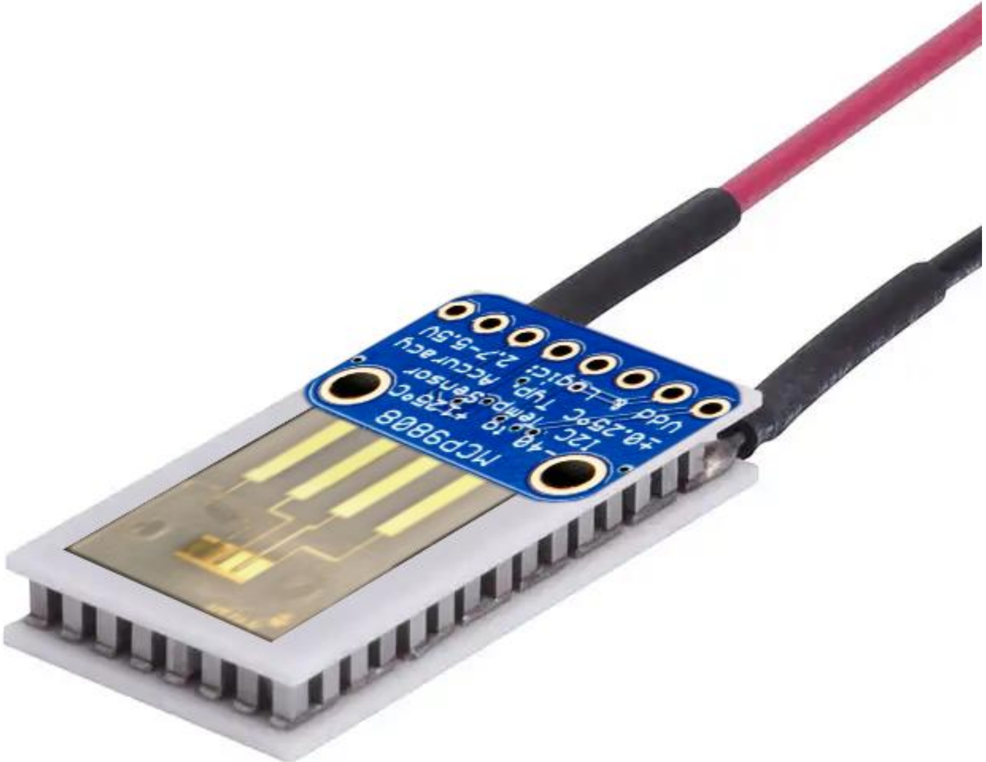


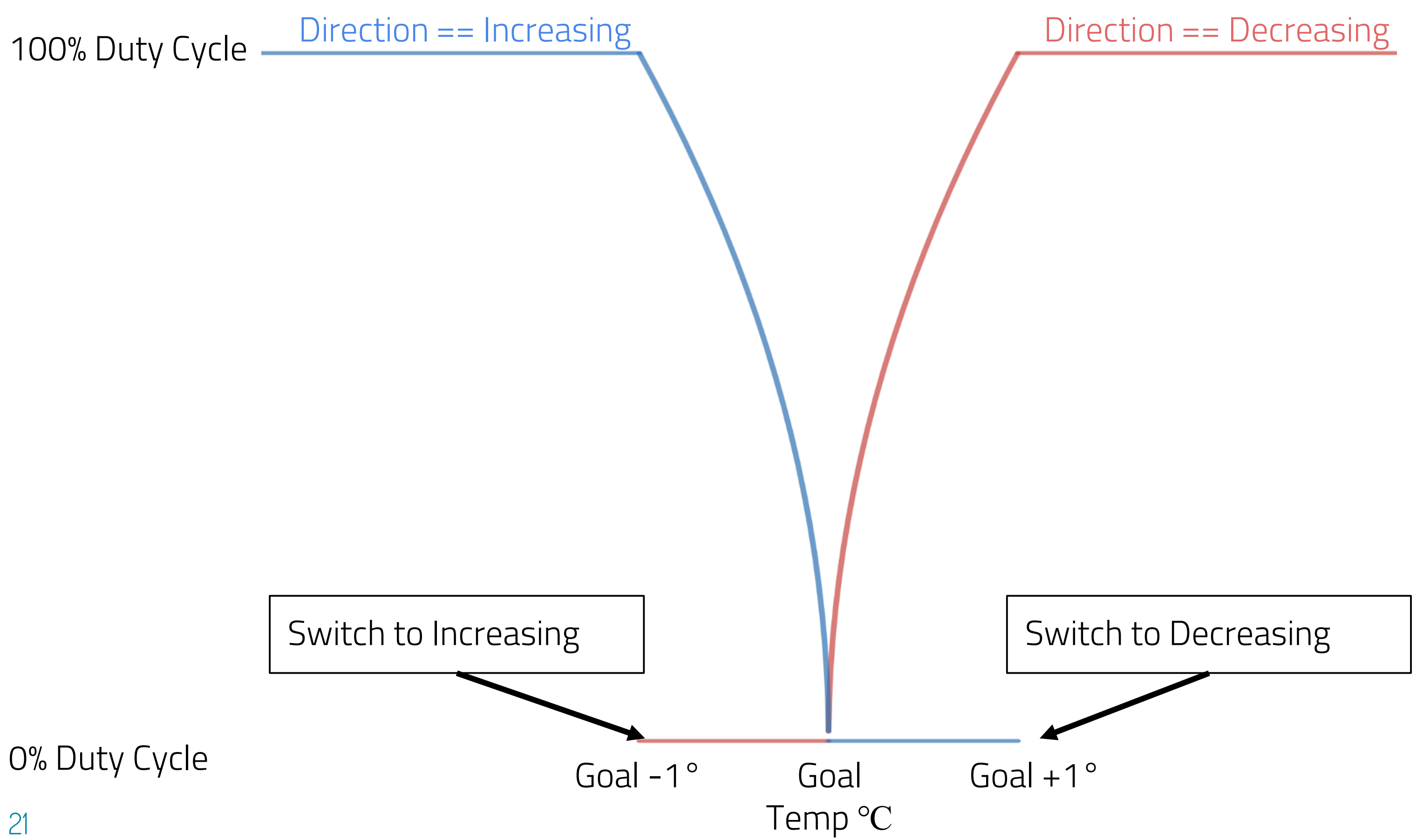

MCP9808
-40 to +125°C
I2C Temp Sensor
±0.25°C Typ. Accuracy
Vdd & Logic: 2.7-5.5V

# Software - Temperature Feedback and Control

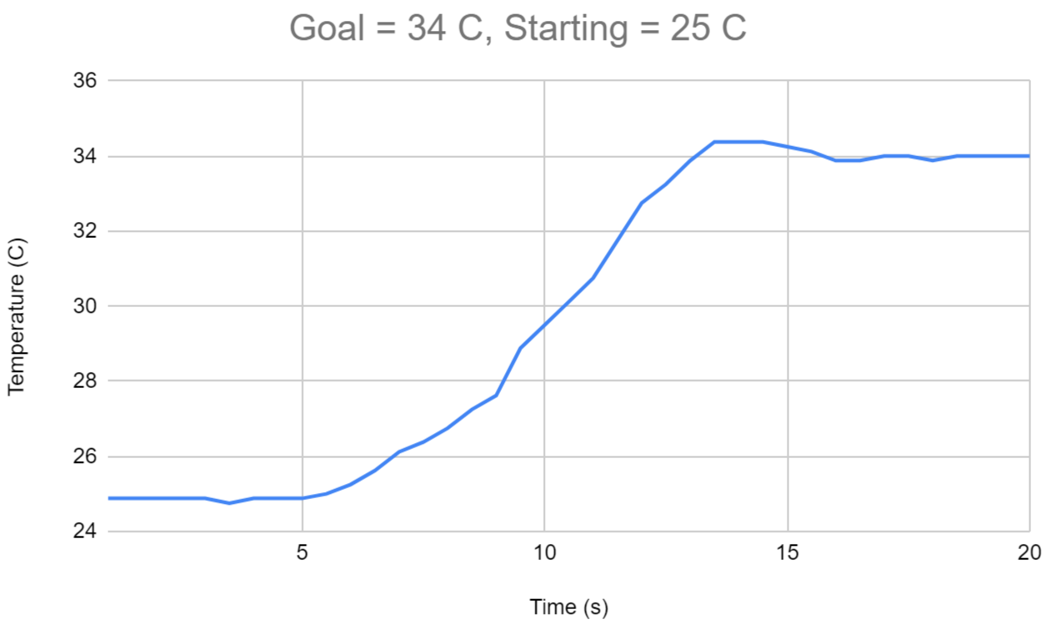
- Initial:
    - Set Goal Temperature
    - Initialize PWM to 10kHZ
    - Set PWM Duty Cycle to 0

- Loop:
    - Get temperature sensor reading
        - Wake temperature sensor
        - Sleep temperature sensor
    - Get direction from current reading
        - Set H-Bridge direction
    - Get duty cycle from current reading
        - Set H-Bridge duty cycle

# Temperature Reading to H-Bridge Duty Cycle/Direction Algorithm



- 1*C stability constraint



# Conclusion

- Temperature Control System
- Power and USB Challenges
- Physical Design Constraints