

**Screws Loose**

Project Deliverable F - Prototype I and Customer Feedback

**Group 9**

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**1. Simple Analysis:**

In our prototype, the SAMD21 microcontroller is critical for processing input signals and executing program commands. Since it's the main processing unit, any malfunction or incorrect coding could halt the prototype's operation. The 2 PIR sensors detect bat movement by sensing changes in infrared radiation, while the thermocouple is included to monitor temperature changes within the bat box. This data will help assess environmental conditions and can reveal patterns in bat activity relative to temperature. The 5V power supply ensures consistent voltage, vital for stable performance, as even slight variations could disrupt sensitive electronics. Using the Arduino IDE enables efficient program uploading and debugging, enhancing the likelihood of error-free code execution. Additionally, breadboards and jumper wires facilitate a modular setup for testing, but due to potential loose connections, careful attention to wiring is necessary to ensure stability and avoid short circuits during operation.

**2. Prototype 1&2 Results:**

*Note: higher priority means more importance*

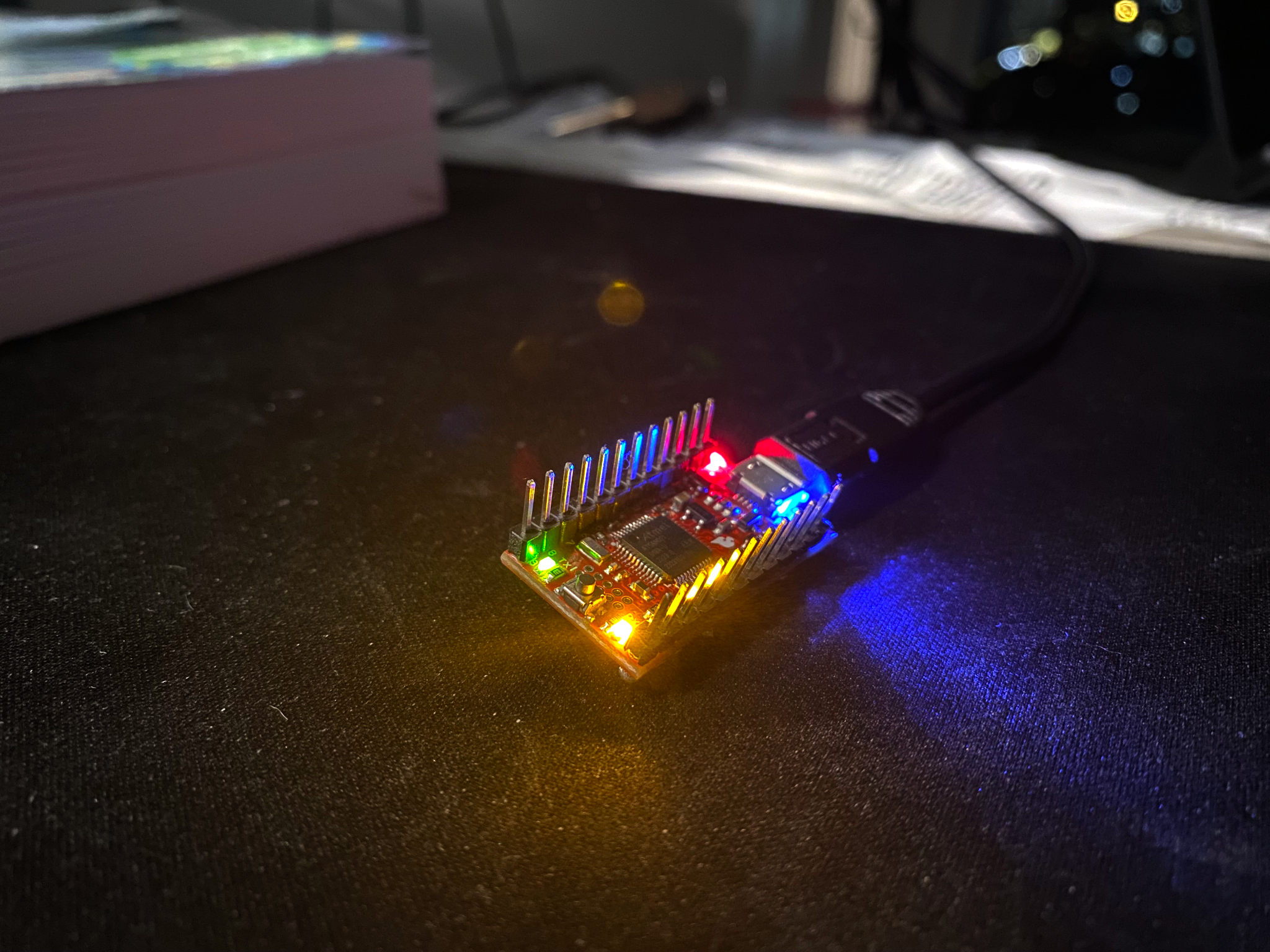
| **Prototypes** | | | | **Tests** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Type** | **Objective** | **Priority (1-3)** | **Method** | **Expected Results** | **Duration** | **Results** |
| 1 | Core Function: Microcontroller | Does the microcontroller program run as intended | 3 | Run the program on the microcontroller | Program runs without producing errors | ~30-50 min | Successful.  LED blink runs as expected. |
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| 2 | Core Function: Sensors | Do the individual sensors function as expected | 3 | Set up the system as intended. Model a bat to mimic movements in and out of the box | Observe if sensors detect movement accurately | ~30-50 min | Partial Failure.  The Thermocouple worked as expected. The PIRs worked but would only detect movement at certain depths. |
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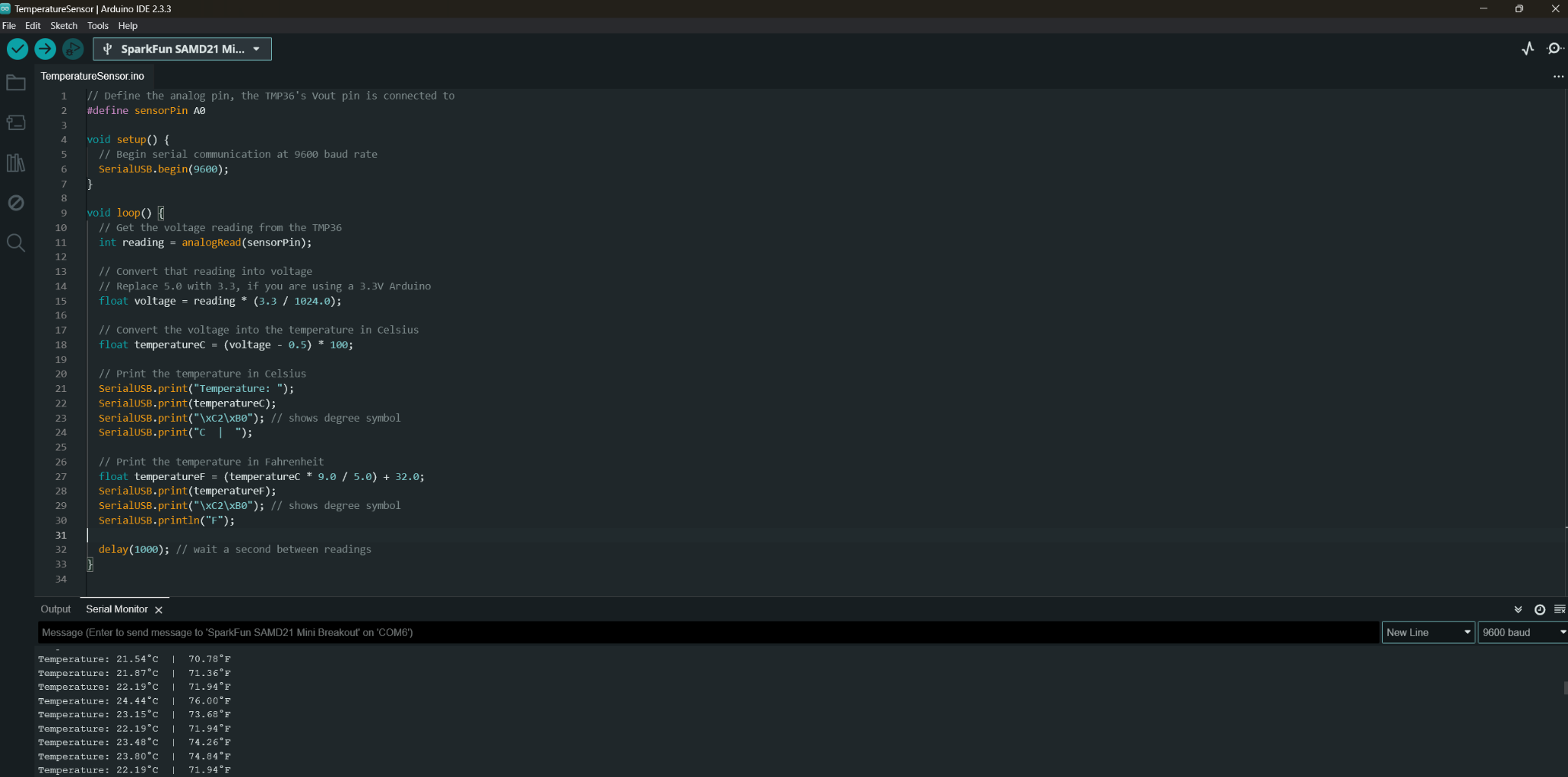
**3. Prototype Reflection and Future plans:**

In testing our second prototype, we found partial success with our components: the thermocouple performed as expected, accurately capturing temperature data within the bat box. However, the PIR sensors, while operational, proved unreliable at specific depths and struggled to consistently detect movement. This inconsistency in the PIRs indicates that further adjustments to sensor positioning and sensitivity settings are necessary to achieve reliable results.

Moving forward, we plan to experiment with different PIR configurations and settings such as sensor range and placement depth to enhance detection accuracy. We’ll also consider testing alternative sensor models if these adjustments do not yield improvement, as the PIR models we used could potentially be faulty. By iterating on these elements, we aim to create a more reliable and robust design for the final prototype.

**Image 1. Board LEDs On — Verifying Operational Status**



**Image 2. Thermocouple Code — Displaying Temperature Measurement Code**

**4. Concept Feedback Summary:**

To enhance the design’s effectiveness, we presented our concept to four groups in our lab session for input on key areas, such as functionality and user applicability. Their comments and suggestions were invaluable for refining both aspects of the project, ensuring that our design aligns with real-world expectations.

| **Group Number** | **Feedback on Concept** | **Feedback on Prototypes** |
| --- | --- | --- |
| Group 6 | Positive feedback, no suggestions made | Suggested better cable management |
| Group 7 | Positive feedback, no suggestions made | Suggested using a laser-cut box for the enclosure |
| Group 8 | Positive feedback, no suggestions made | Positive feedback, no suggestions made |
| Group 10 | Suggested considering solar panels to prolong battery life | Positive feedback, no suggestions made |
| Teaching Assistants | Suggested addition of a Flow Chart to the deliverables | Suggested reevaluation of time constraints and overall prototype expectations |

**5. Prototype Plan (Types: Structural: Integrity/Cable Management & EOA, Core function: Sensors/Microcontroller/System )**

*Note: higher priority means more importance*

| **Prototypes** | | | | **Tests** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Type** | **Objective** | **Priority (1-3)** | **Method** | **Expected Results** | **Duration** | **Team member(s)** |
| 1 | Core Function: Microcontroller | Does the microcontroller program run as intended | 3 | Run the program on the microcontroller | Program runs without producing errors | ~30-50 min | Amin  Mohammed  Waleed |
|
|
| 2 | Core Function: Sensors | Do the individual sensors function as expected | 3 | Set up the system as intended. Model a bat to mimic movements in and out of the box | Observe if sensors detect movement accurately | ~30-50 min |
|
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| 3 | Core Function: Sensors | Do the sensors work as expected, in tandem. | 3 | Set up the series of sensors as intended. Use the same bat model from Prototype 2 | Observe if all sensors detect movement in the expected order, under varying conditions | ~1-2 hrs | Amin  Mohammed  Waleed |
| 4 | Core Function: Data Processing | Does the system log data in the correct format on the micro SD card and NFC module | 3 | Use sensors from Prototype 3 to log data to SD card | Check file structure and formatting to work as listed in Fig. 2 | ~1-2 hrs | Amin  Mohammed  Waleed |
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| 5 | Core Function: System | Verify Accuracy, Precision, and error bounds | 2 | Test system's output against known standards or simulated bat data | Data output matches expected precision and accuracy | ~1 hr | Hossam  J’afar |
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| 6 | Structural:  Enclosure Integrity | Inspect for weaknesses, potential points of failure, and waterproofing | 3 | Evaluate enclosure in various simulated environmental conditions | Enclosure maintains integrity without leaks or damage | ~24-48 hrs | Hossam  J’afar |
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| 7 | Structural:  Cable Management and Ease of Access | Verify speed of replacement and check cable channel options | 2 | Test cable arrangement options and inspect ease of access during battery replacement | Cables are secure, the battery is easily replaceable, and safely routed within the time frame | ~30 min | Hossam  J’afar |

*Materials needed for each prototype*

| **Prototype ID** | **Equipment Needed** | |
| --- | --- | --- |
| **1** | * SAMD21 microcontroller * Breadboard * Jumper wires * Power supply (5V) * Arduino IDE |  |
| **2** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * TMP36 Thermocouple * Boost Converter * Arduino IDE * Power supply (3.7V) |
| **3** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * Load cell with HX711 amplifier * Boost converter * Arduino IDE * Power supply (3.7V) |
| **4** | * SAMD21 microcontroller * Micro SD card and breakout board * NFC PN532 chip * Breadboard * Jumper wires | * Arduino IDE * Boost Converter * Power supply (3.7V) |
| **5** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * Load cell with HX711 amplifier * Boost converter * Arduino IDE * Power supply (3.7V) |
| **6** | * Enclosure (made of ABS material) * Sprinkler * Paper towel * Fridge | * Heater |
| **7** | * Battery * Enclosure (made of ABS material) * Cables * Bat box model | |

**6. Bill of Materials**

| BOM Level | Parts and Components | Part Number | Unit Cost | Quantity | Total Cost |
| --- | --- | --- | --- | --- | --- |
| 2 | [Passive Infrared Motion Sensor](https://www.pishop.ca/product/hc-sr501-pyroelectric-infrared-pir-motion-sensor-detector-module/) | HC-SR501 | $ 3.95 | 2 | $ 7.90 |
| 2 | [Load Cell](https://www.amazon.ca/Bridge-Digital-Amplifier-Arduino-DIYmalls/dp/B086ZHXNJH/ref=pd_sbs_d_sccl_2_2/138-3904992-8608018?pd_rd_w=hPXKX&content-id=amzn1.sym.6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_p=6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_r=63A5P5HXPR0KJP7T57CN&pd_rd_wg=nVFN2&pd_rd_r=661fe043-3687-4b71-8af3-f57dc95169b9&pd_rd_i=B086ZHXNJH&psc=1) | SEN-10245 | $ 12.98 | 4 | $ 12.98 |
| 2 | [Amplifier](https://www.amazon.ca/Bridge-Digital-Amplifier-Arduino-DIYmalls/dp/B086ZHXNJH/ref=pd_sbs_d_sccl_2_2/138-3904992-8608018?pd_rd_w=hPXKX&content-id=amzn1.sym.6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_p=6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_r=63A5P5HXPR0KJP7T57CN&pd_rd_wg=nVFN2&pd_rd_r=661fe043-3687-4b71-8af3-f57dc95169b9&pd_rd_i=B086ZHXNJH&psc=1) | HX711 | 1 |
| 1 | [SAMD21 Microcontroller](https://www.amazon.ca/gp/product/B0CBSYZKRF/ref=ewc_pr_img_1?smid=A33HV3N1GS7LPU&psc=1) | DEV13664 | $ 39.06 | 1 | $ 39.06 |
| 2 | [MicroSD Card Breakout Board](https://www.pishop.ca/product/microsd-card-breakout-board/) | ADF-101 | $ 11.95 | 1 | $ 11.95 |
| 2 | [Bi-Directional Voltage Booster](https://www.pishop.ca/product/4-channel-i2c-safe-bi-directional-logic-level-converter-bss138/) | ADF-100 | $ 5.45 | 1 | $ 5.45 |
| 1 | [3.7V 9000mAh Lithium Ion Battery Pack](https://www.aliexpress.com/item/1005007348720830.html?spm=a2g0o.productlist.main.45.1f904NSB4NSBBz&algo_pvid=7e193194-c09a-4757-b303-b0c1624b3504&algo_exp_id=7e193194-c09a-4757-b303-b0c1624b3504-22&pdp_npi=4%40dis%21CAD%2110.24%218.19%21%21%2151.53%2141.22%21%4021030ea417298962135003816e1950%2112000040366349780%21sea%21CA%210%21ABX&curPageLogUid=xK1vLOKedbai&utparam-url=scene%3Asearch%7Cquery_from%3A) | GL-18650 | $ 10.28 | 1 | $ 10.28 |
| 2 | [TMP36 Temperature Sensor](https://www.pishop.ca/product/temperature-sensor-tmp36/) | SEN-10988 | $ 2.95 | 1 | $ 2.95 |
| 3 | [ABS Filament (Container, Buckle)](https://www.pishop.ca/product/abs-1-75mm-filament-silver-1kg/) | ABS-2069 | $ 0.02 | 100 | $ 2.50 |
| 1 | [Wire Spool](https://www.pishop.ca/product/solid-core-wire-spool-25ft-22awg-yellow/) | ADF-1658 | $ 3.95 | 1 | $ 3.95 |
| 1 | [Battery Connector](https://www.pishop.ca/product/jst-to-breadboard-jumper-3-pin/) | SF1552 | $ 2.77 | 1 | $ 2.77 |
|  |  |  | Total | 113 | $ 99.79 |

*Note.* For the ABS filament, the quantity is in grams. The table excludes any taxes. Created by Mohammed on October 26th, 2024